GUIDE FOR TECHNICAL WRITERS
GUIDE
FOR
TECHNICAL WRITERS

CARDI COMMUNICATIONS GUIDE NO. 2

Don Walmsley
Editor

Caribbean Agricultural Research and Development Institute
with assistance from
Technical Centre for Agricultural and Rural Cooperation
The Caribbean Agricultural Research and Development Institute (CARDI) was founded in 1975 as an autonomous institution of 12 member countries of the Caribbean Community (CARICOM). The member countries are: Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago. The governing body is the Standing Committee of Ministers responsible for Agriculture, and the board of directors is drawn from member governments and regional agencies. CARDI's mission statement is: To accelerate sustainable agricultural development through strategic management of those processes that generate, transfer and commercialize appropriate technology that will improve the social and economic well-being of Caribbean people.

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The Technical Centre for Agricultural and Rural Cooperation (CTA) was established in 1983 under the Lomé Convention and is based in Ede-Wageningen in the Netherlands. Its mandate is to help the African, Caribbean and Pacific countries which comprise the ACP group achieve greater food security by providing them with better access to scientific and technical information on all issues related to agricultural and rural development. Working in close cooperation with ACP and EEC countries and with international, regional and national institutions, CTA fulfills its mandate through a range of activities, including seminars, studies, publications and support to ACP documentation centres.

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ISBN 976-617-002-9
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PREFACE

The ability to communicate effectively is essential for every agricultural scientist. Without this ability workers may do excellent work without it having any impact. Important discoveries may never be made available to fellow agriculturists or the farming community. The implications of new technologies may not be fully understood by politicians and policy-makers. Opportunities to develop new and better farming methods may not be followed up.

In order to communicate effectively the professional agricultural scientist, like anyone else, must be able both to speak and to write well. Clear verbal presentations, supported by good visual aids are required at meetings, seminars, workshops and conferences. Clearly written documents are required for articles in scientific journals, annual reports, reports to donor agencies, technical bulletins, factsheets and other material published by CARDI.

This guide is concerned with written material. It should be borne in mind when producing a technical paper that writing is as important as the work that led to the information it is based on. Thus, it follows that the writing process may take a considerable amount of time if it is to be done properly.

The purpose of this guide, commissioned by the CARDI Communications Unit, is to help to improve the quality of technical written material. Though produced primarily for CARDI staff, it is hoped that the guide may also be of use to others engaged in similar work in the region.
ACKNOWLEDGEMENTS

This guide is based on papers prepared by Denyse Johnston, Bruce Lauckner and Don Walmsley for a series of workshops on technical writing organized by the Caribbean Agricultural Research and Development Institute (CARDI) and the Technical Centre for Agricultural and Rural Cooperation (CTA).

The financial assistance provided by CTA for the production and publication of the document is gratefully acknowledged.

Thanks are also due to Alison Eades* of CARDI’s Communication Unit who has given valuable advice and criticism at all stages during the preparation of the guide and made a major contribution to the section on Writing Reports.

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* On attachment from the Natural Resources Institute, UK.
1. INTRODUCTION

If you are in need of this guide you are likely to understand the importance of good communication in any line of work. Agricultural research and development has a history of information being generated but remaining in a dusty corner of the library. With greater drives for effective R&D, a greater need to raise the profile of the work undertaken, and greater demands for accountability, the need to develop good communication skills is being increasingly recognized. The art of clear report writing is one of those skills.

This guide deals specifically with project reports and scientific papers, the fundamental principles of which are the same. Writing for the ultimate end-users, extension workers and the farming community, requires a different approach.

There are four basic questions that need to be asked before writing begins:

• **Who is it for?**
  Knowing your ‘audience’ is of paramount importance. What sort of people are you targeting? Line managers? Ministries of agriculture? Donor agencies? Scientific peers?

• **What does the audience need to know?**
  What is your message? What are trying to achieve by writing the report, and are you giving the correct information to achieve your objective?

• **What does the audience already know?**
  Giving too much information is as frustrating for a reader as giving too little. How much background do they need?

• **How can the message best be presented?**
  In what form will the information be best assimilated by the reader? Think about the type of language to use, use of tables and graphs, bullet points, short sections or full discussions.

Being clear about your objectives and knowing your audience are the two main considerations. Read the initial project document to remind yourself fully of the stated objectives for the work undertaken and approach your writing accordingly. Knowing your audience determines the way you present your information with particular regard to the use of language, jargon, statistical analysis, and physical presentation. Also remember their needs: a chief executive will concentrate on the introduction and recommendations; a scientist will pay more attention to methodology, discussion and conclusions. Both will read a summary.

Bear these points in mind when writing any technical paper or report. The following sections go into some detail on the mechanics of good technical writing.
2. WRITING TECHNICAL PAPERS

A research paper is among the important documents a scientist has to write. It is the means by which the results are made known to peer scientists and communication specialists. It will probably have a bearing on the adoption of new technology. The reputations of both the research organization and of the scientist are judged by the standard of the paper.

Research papers are written in the same style whether for presentation at a conference or for acceptance by a journal. The target audience is essentially the same – mainly research scientists and some extension specialists. However, it is important to remember that the written paper should not be presented verbally at the conference. The presenter should summarize the contents and speak either from a specially prepared summary written in a suitable style for verbal delivery, or from notes.

Planning

Four things need to be done before writing a paper:

- Assess whether the work is ready for submission.
- Decide whether to write a short paper or a more detailed one.
- Decide who the readers will be and which journal the paper will be submitted to.
- Obtain the journal's notes to authors and read them carefully.

In project work and research, writing should be part of the investigation and not an unwelcome task to be undertaken at the end. Even though detailed notes are kept as the investigation proceeds, a start can be made on the paper before the practical work is over. This is because research papers are normally structured in such a way that the writing of certain sections can start before the research is finished. Of course, this is made easier nowadays because word processing makes it possible to update, rearrange and edit whenever necessary. By working in this way it will be possible to publish the paper earlier than would otherwise be the case, and timely publication is desirable for obvious reasons.

In planning, therefore, both the practical research and the paper should be considered together. The stages of producing a paper are shown diagramatically in Figure 1.

Literature searches may save a lot of time in planning and avoid unnecessary repetition of effort.
Figure 1  Stages in preparation of a research paper
Writing during the research stage

Writing should not be left to the last moment. The following points should be borne in mind during the research:

- Keep records made during an investigation in a laboratory or field notebook, not on scraps of paper.
- Every note should be dated and the time of the observation noted.
- Remember to make a duplicate of the notes. If a computer is used it is easy to back-up the diskette regularly.
- In project work, write an account of the observations and experiments as the project proceeds. Think of the report as part of the investigations.
- Use writing and drawing as aids to observation and description. Observation is the basis of science and preparing a description, like making an accurate drawing helps to focus attention on an object or event. Writing is necessary for precise description and is an aid to thinking and learning.

Peer review

A good way to assess progress is to present the methods and results orally or in poster form at a departmental seminar, or at a meeting whose proceedings will not be published in full. The comments and questions at the meeting will help in deciding whether the work is ready for submission to a journal.

The structure of the paper

The structure refers to the way in which a paper is divided into sections and subsections or paragraphs. These include: the title; the author or authors; the organization and its address; an abstract; keywords or index terms; an introduction; materials and methods used; the results and/or observations; a discussion of the results; conclusions drawn from the results or summary, acknowledgements to those who have helped in any way; a list of references to the work of others cited in the text.

Deciding on the detailed structure is part of the planning process. Most journals follow a similar arrangement to the one shown below, though there are minor differences in the style of presentation used. The writer of a paper intended for publication in a particular journal must therefore be aware of the style required by that journal.

Title

The title is the first and most important part of any communication. The choice of a good title ensures that it will attract the attention of those who might wish to read part or the whole paper. The information given in the title should be as brief as possible but allow the reader to have a good idea of what the article is about. Use common names for crops if possible; when the scientific name of a plant is used it is not necessary to include the authority.
Author(s) and organization

The name(s) of the authors and the organization(s) under whose auspices the work was done should appear under the title. Usually only the initials of an author's first names are given.

Abstract

The abstract is for readers who may not need to read the whole paper; it is used in documentation and information retrieval systems. It should not be longer than about half a page (100–250 words) and should contain information on the following: why the work was started; how it was done; the main findings; and their implications.

The abstract can only be written when the report is otherwise complete, although it is normally placed at the beginning. Nothing should be included in the abstract that is not also in the main body of the paper.

Keywords/index terms

These make up a list of words or phrases intended as indexing and cataloguing entries. When they form part of a computerized database they allow easy reference to the paper. Words that appear in the title should not usually be included among the keywords but check what the particular journal requires. Keywords generally appear immediately after the abstract.

Introduction

The introduction (usually one or two paragraphs) should contain the following:

• The historical and other background information providing a setting or context in which the work was carried out.

• The purpose and scope of the paper.

• In some cases, an indication of the way the paper is presented such as the organization of sections, how the argument is to be developed, etc.

Materials and methods

Information on everything concerned in setting up the trials should be included here, e.g. climate and soil characteristics, plant cultivars, breeds of livestock, fertilizers and other agrochemicals used, cultivation practices, feeds and pasture types, experimental design, treatments, parameters measured, methods of measurement, analytical methods, methods of assessing the results. Some of these may form sub-sections with appropriate sub-headings. Tables and/or diagrams should be used to illustrate or help explain the text. Enough detail should be included to ensure that if the investigation were repeated by someone else with experience in the same field, similar data could be obtained.

Results

This section, written in the past tense, should provide a factual statement of what was observed, supported by any statistics, tables or graphs derived from the analysis of the data recorded. The presentation of numerical results is discussed in Section 5 of this guide.
Discussion

This should be an objective consideration of the results and should lead naturally to the main conclusions. An explanation may be offered as to why certain results were obtained in the circumstances of the trial. Implications of the results may be discussed. The way in which the results cast any light on the problems mentioned in the introduction should be referred to here. An indication of how the work fits into the background of previous investigations should be included here.

Often it is more convenient and makes for easier reading to combine the discussion and results under one heading: Results and discussion

Conclusions

The conclusions usually go a stage further than the discussion. They are the view(s) taken by the writer as a consequence of what has been discovered in the research. They sometimes represent a bridge between the discussion and recommendations for farmers. Extension specialists might therefore look first for this section of the paper.

Recommendations

These are sometimes called for in a report but are not normally included in a scientific paper.

Acknowledgements

It is courteous to acknowledge help that has been given in carrying out the research and producing the paper. As well as scientists providing technical advice, help may also have come from organizations that made their facilities available, and from funding agencies.

References

The purpose in giving references is to acknowledge the use of other people’s work so that they may be given credit for it, and to enable the reader to refer to cited work for further information.

The reference styles in general use are discussed in Section 4 (Writing Style), but each journal may have its individual variations and the style of the target journal should be checked.

Appendix

Appendices (or annexes) are not often found in journal papers but are common in reports. They contain background information which may be helpful to the reader but not essential to the report.
Stages in the writing process

The paper should be an objective and accurate account of a piece of research done by the author. It only calls on the work of others to substantiate arguments made in the paper.

With respect to writing style (which is discussed in detail in Section 4), the paper should have:

- Precise logical sentences
- Clear and concise English
- The particular style demanded by the journal to which it will be submitted.

Not all of these will be achieved in one attempt. Instead, plan to write a series of drafts each improving on the one before it and concentrating on a different ingredient. There is nothing wrong with writing good English or complying with the style of the journal at the early stages but this should not be allowed to hold up the effort.

The stages involved in writing a paper may be summarized as follows.

Building the framework

- Agree who the authors are and the order of their names
- Write a working title
- Decide on the structure by choosing the main headings (the conventional ones are listed above)
- List the points that belong under each heading

First draft

- Find a time and place for writing and collect all the material needed
- Start with the easiest section, write simply inserting headings
- Write the introduction, materials and methods, and results sections
- Make a preliminary presentation to colleagues
- Write the discussion section
- Revise the working title
- Write an informative abstract
- Provide keywords
- Write the acknowledgements section
- Put the draft to one side for a while

Second draft

- Check for logic and order
- Check tables and figures
- Check citations and quotations
- Check the length of the draft
Third draft

- Make sure that the correct person, voice and tense have been used
- Remove all unnecessary jargon
- Check grammar
- Obtain comments from any co-authors and from selected colleagues

Final draft

- Put sections in correct order and number pages
- Prepare title page with authors names in the agreed order and the way they prefer
- Address matters of technical style – italicization, capitalization, hyphenation, abbreviations, punctuation, numbers, etc.
- Put table headings and figure legends in the recommended style
- Take particular care to provide complete references
- Obtain final criticisms from co-authors and others
3. WRITING REPORTS

If research work is to be written up for a scientific audience it will often take the form of a paper for submission to a conference or specialist journal. The process for producing such a paper is outlined in Section 2. The work, however, may be written up more fully as a project report which requires a somewhat different layout and approach. A report generally contains more information and is used by managerial as well as technical staff.

Starting

Much of what appears in Section 2 with regard to planning and writing a technical paper is also relevant to writing a technical report.

The best way to start compiling a report is to gather together all the information in whatever form it may be—working notes, previous reports, raw data, ideas, and guidelines, if any. Sort the material discarding any that has become irrelevant, out of date, or has been superseded. Order the useful material into sections and make sure you are familiar with it all so that your discussion will be logical and cohesive.

Outline a brief structure for the report, perhaps creating an initial contents page. The structure can always be changed at a later date as the report begins to take shape.

There are several factors of which to be aware during production, the first being the purpose of the report. It is all too easy, and a frequent trap, to write in excessive detail about the work you undertook, presenting all the data you have accumulated. You are not being judged on the amount of time you spent on this work; that is an aspect of job performance appraisal. A report provides an opportunity to present the facts as you found them, to analyse, discuss, draw conclusions and make recommendations for future action. Keep your objectives in mind.

Section 4 of this guide discusses the use of language and proposes some simple guidelines to follow to ensure your report or paper is clear and to the point. When using jargon remember your audience: if you cannot avoid it, explain any technical words or phrases that readers outside your field of study may not fully understand. The most frequent and mistaken response to an editor requesting more explanation is: "everyone knows what that means". Never assume the reader has an in-depth knowledge.

Within each section, break the writing into distinct paragraphs. This helps not only with separating ideas or points to be made, but also helps the reader by visually breaking up the text. The use of tables and figures also helps to achieve this. Present the information in a logical fashion. State the facts, analyse them and make your point. Support your point with further discussion, table or graph showing the data, or even a line drawing or photograph. Then move on to the next point.
Layout

A reader requires a certain amount of guiding through a document and full use should be made of ‘signposts’. Some of these are obvious such as the contents page, section headings and subheadings. But other tools are less obvious: references to tables and figures, appendices, and the use of italic or bold text.

Three levels of heading is the norm and these also help to break up the text. Four levels are acceptable, but five begin to complicate the presentation. If you find you are creating five levels of heading, reorganize your text into more sections.

A reader needs a certain amount of white space on a page. Small type and narrow margins make the text more difficult to read. Leave space between text and headings. Insert page numbers and make suggestions to the typist if you feel the type size is too small or too large.

Structure

Often there is a particular format a report should follow, depending on its intended usage or the requirements of the requesting agency. In the absence of any given structure, use the following outline as a guide.

- Front cover
- Title page
- Verso of title page
- Contents
- Preface
- Abbreviations
- Acknowledgements

Summary

Body of the report (divided into sections)
- Introduction
- Objectives
- Methods
- Results
- Conclusions
- Recommendations
- References (if appropriate)

Appendices

Note that this format differs in several aspects from that for a scientific paper given in Section 2. This is because a report is designed to be complete in itself and will not later appear in a journal or proceedings of a conference.

Front cover

The information on the front cover should be brief. There should be a concise title which clearly reflects the nature of the material in the report. If appropriate, the logos of the organizations involved should be displayed. It should have an attractive appearance.
Title page

The full title and any subtitle should be included on the title page. The name of the publishing organization should be spelled out in full along with its short address. The family names of author(s) or editor(s) are usually given with initials but sometimes the first name may be also written out in full. The date of publication appears here; usually only the year is necessary. Other information such as the project number and the commissioning agency may be required. This is always a right-hand page and not numbered.

Verso of title page

The title page verso appears on the back of the title page and is not numbered. It gives the full name and address of the publisher, and a copyright statement (if necessary). If available, the ISBN or ISSN appears on this page. Also, it may be appropriate to give a short description of the organization(s) involved.

Contents

The table of contents serves two purposes: it enables the reader to find quickly any section of the report and it provides a quick and comprehensive view of the plan of the report. It is not always necessary to include all levels of headings – use your own judgement. Page numbers are given for each section; double check that they are correct in the final version. The contents table always starts on a right-hand page and is usually numbered with a lower case roman numeral, e.g. (iii).

Preface

The preface explains why and how the publication came to be written. It is not always necessary to include one. (Lower case roman numerals are used for the page numbers).

Abbreviations

A list of the abbreviations and acronyms used in the report is always helpful and should include even the more obvious ones. (Lower case roman numerals are used for the page numbers).

Acknowledgements

It is courteous to acknowledge any help that has been given by other people in compiling the report.

Summary

A summary is important for readers who may not need to know all the details and also for those who do not have time to read the whole report but need to know about it. A summary should not be longer than one or two pages and should contain a brief statement of the objectives, the main findings in the same order as they appear in the body of the report, the conclusions and recommendations (if applicable). Nothing should be included in the summary that is not also in the report.

Where an executive summary has been requested, this should involve a précis of each section of the main report. An executive summary may be longer than the normal summary and run to several pages.
Body of the report

The body of the report presents in detail the information which you want to communicate. Apart from there always being an introduction, it is difficult to give a general outline on how to organize this material. You must decide what arrangement of the facts is most clear and systematic, and then try to convey the logic of that arrangement to the reader.

Remember also that you will not necessarily be writing about your work in the same chronological in which you did it.

In spite of variations, the framework for most project reports could include the following sections:

  Introduction: Why did you do the work? What is its purpose?
  Methods: What materials did you use? How did you use them?
  Results: What did you find or see?
  Discussion: What do your findings mean?
  Conclusions: What are your conclusions based on the evidence presented?
  Recommendations: What actions do you recommend for the future?
  References (or bibliography): What previous work has been cited (or is relevant)?

The pages of the body of the report are numbered using arabic numerals centered in the bottom margin.

Use headings and subheadings; they enable readers to quickly find the facts they want. Like textbooks, reports are used for reference and are not necessarily read through from beginning to end. Use concise wording for subheadings, not lengthy sentences. Compose the sentence following a heading so that it is complete in meaning without the heading; avoid pronouns referring to the heading. For example, if the heading is ‘World trends’, begin the first paragraph with ‘World trends indicate . . .’ not ‘These indicate . . .’.

In writing the introduction it is particularly important to remember who the report is for and what they know already. The introduction should contain the purpose and scope of the report (or terms of reference) along with historical and other background information providing a setting, or context, in which the work was done. Sometimes it is useful to say how the report is presented such as the organization of sections, and how the argument is to be developed.

The methods or methodology is structured according to the type of work being presented. It must be clear how the work was carried out and each paragraph should logically follow from the previous. The content may be similar to that described on page 5.

The conclusions are the views of the writer on what has come out of the report. Such judgements should be logical and avoid bias. For the benefit of those readers who will not read the whole report, the conclusions should be presented separately from the results section.

The recommendations should also be given in a separate section. They indicate your suggestions about what should happen next. Without recommendations readers are left to make their own judgements or may be at a loss as to how the information can be used.
The purpose of giving references is to acknowledge the use of other people's work so that they may be given credit for it, and to enable the reader to refer to cited work for further information. Reference styles are discussed in Section 4 and in more detail in the *Style Guide for Technical Editors* (Walmsley 1996).

**Appendices**

Add appendices to the report if you have material that is not essential to the text but would be helpful to readers seeking clarification and supporting data. These may include chemical and statistical analyses, questionnaires, maps, flow sheets, etc.

One of the problems in planning a report is to decide what material belongs to the text and what to the appendices.

The appendices should be numbered and listed in the table of contents.
4. WRITING STYLE

A technical report is usually formal in language and tone; personal pronouns are avoided as far as possible. However, this does not mean that it has to be dull or difficult to read. Writing with an active rather than a passive approach is preferred when possible. The report must be clearly understood by all who read it and the style in which it is written is fundamental to achieving this. Thus the style should be simple and precise. A useful test to apply is to ask: would a reader whose first language is not English have any difficulty in understanding the article in its present form? The style can be improved by keeping it simple, avoiding verbosity and imprecision.

Vocabulary

Use words that are easily understood; remember the purpose is to convey information rather than impress the reader.

Use short rather than long words if they have the same meaning:

<table>
<thead>
<tr>
<th>Long word</th>
<th>Preferred word</th>
</tr>
</thead>
<tbody>
<tr>
<td>anticipate</td>
<td>expect</td>
</tr>
<tr>
<td>approximately</td>
<td>about</td>
</tr>
<tr>
<td>commence</td>
<td>start/begin</td>
</tr>
<tr>
<td>demonstrate</td>
<td>show</td>
</tr>
<tr>
<td>elevated</td>
<td>raised, higher, more</td>
</tr>
<tr>
<td>encountered</td>
<td>met</td>
</tr>
<tr>
<td>possess</td>
<td>have</td>
</tr>
<tr>
<td>purchase</td>
<td>buy</td>
</tr>
<tr>
<td>terminate</td>
<td>end</td>
</tr>
<tr>
<td>utilize, employ</td>
<td>use</td>
</tr>
</tbody>
</table>

Use words with precise meaning. Avoid over-use of 'very', e.g. very flat, very few. Other vague words/phrases are: rather; a certain amount; comparatively. 'Relatively' should only be used in comparisons – alone it has no meaning.

If possible use the more precise word: 'letter' rather than 'communication'; 'truck' rather than 'transport'; 'profitable' rather than 'viable'.

Make sure of the meaning of every word. Take care with easily confused words:

| absorption | adsorption |
| accuracy   | precision  |
| adapt      | adopt      |
| adverse    | averse     |
| affect     | effect     |
| among      | between    |
| can        | may        |
| compliment | complement |
compose
continual
discrete
enable
ensure
farther
incidence
infer
juncture
militate
principle
presently
that
varying

comprise
continuous
discreet
permit
insure
further
prevalence
imply
junction
mitigate
principal
at present
which
various

Note that 'programme' is the usual spelling except when referring to computers when 'program' is preferred:

The food crops programme involved investigations on . . .
The software included a program for processing data.

Sentence length and structure

Long words and complicated sentences are not essential features of good scientific writing. Sentences that are reasonably short and simple are generally more easily understood than those which are long and complicated. Although excessive length is not easily defined, sentences of 10–25 words (40 maximum) should be aimed at as a general preference. Nevertheless, it is important to vary sentence length – a series of 10-word sentences is just as monotonous as a series of 60-word sentences. In revising the typescript, any sentence of more than four or five typed lines should be examined to see if it could be rewritten as two sentences.

Too many subordinate clauses and use of many commas can be avoided by breaking the passage up into shorter sentences. For example:

The crossbred calves, although larger than the local breed, fetched a smaller price on the market, due to the fact that buyers, having little experience of them, were naturally cautious.

could be better written as:

The crossbred calves, although larger, fetched less than the local breed in the market. The reason was that buyers had little experience of the crossbreds and were naturally cautious.

It is advisable not to use long noun clusters or strings of adjectives and nouns with no clues about which modifies which:

... flexible resource allocation procedures . . .
... albino rat liver xanthine oxidase activity . . .
Verbosity

Verbosity is a common fault in technical writing and a conscious effort should be made to reduce it. It may be seen in ornate language, in repetition or in the inclusion of words that do not contribute to the meaning. Words and phrases that are not needed should be removed.

Note the improvement in the second sentence:

Although solitary under normal prevailing circumstances, raccoons may congregate in certain situations of artificially enhanced nutrient resource availability.

Raccoons usually live alone but come together when bait is provided.

Sometimes a phrase can be replaced by a single word or even omitted:

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Preferred alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>it is clear that</td>
<td>clearly</td>
</tr>
<tr>
<td>take into consideration</td>
<td>consider</td>
</tr>
<tr>
<td>bring about an increase</td>
<td>increase</td>
</tr>
</tbody>
</table>

‘It is plainly demonstrated from the data presented in Table 2’ means the same as ‘Table 2 shows’

‘Obviously’ should not be used – it may not be obvious to the reader.

If a piece is introduced by ‘Needless to say’, why say it?

Avoid abstract 'tag' words such as certain, factor, condition, overall:

‘The field was in a wet condition’ could be changed to ‘The field was wet.’

‘It was found that disease was not a contributing factor to low yield’ could be better written as 'It was found that disease did not contribute to low yield’.

Examples of unnecessary words commonly found are:

important essentials
consequent results
The reason for . . . was because . . .
The two organizations should merge together
The subject of the talk is about . . .

An example of unnecessarily ornate language is:

The introduction of the grazing animal in large numbers will be detrimental to the visual amenities of the district and consequently incompatible with a campaign to effect an increase in tourism in the region.

A more suitable version would be:

Introducing too many grazing animals would spoil the landscape of the district and thus go against the tourism thrust.
Some of the more common terms to avoid, not because they are wrong but because they could be either omitted altogether or replaced by shorter and less complex phrases, include:

- it is interesting to note that
- due to the fact that
- at the present time
- from the point of view of
- throughout the whole of the experiment
- two equal halves
- if conditions are such that

A more comprehensive list of such terms is given in Appendix II.

Also note that it is unnecessary to put a number in parentheses after it has been spelled out: There were six people in the room, not There were six (6) people in the room.

**Ambiguity**

Phrases such as ‘as mentioned previously’, ‘as discussed above’, ‘see below’ are ambiguous. It is much better to give a less vague indication by referring to a well-defined section and/or page number.

The way in which a sentence is constructed can sometimes cause more than one meaning to be conveyed. The following examples show how easily this can happen.

**Wrong word order**

The crop completely failed to mature.
The crop failed to mature completely.

He asked his wife why she had decided to keep more fowls in the kitchen after supper.
He asked his wife in the kitchen after supper why she had decided to keep more fowls.

**Careless use of pronouns**

After talking with the farmer the reporter found his work dull.

The farmer put his best ram in a shed and later found it had collapsed.

**Incorrect use of ‘that’ and ‘which’**

‘That’ defines and is used to introduce a restrictive clause; ‘which’ describes and is used to introduce a nonrestrictive clause:

He stopped the first car that was driven by a woman and asked for help.
He stopped the first car, which was driven by a woman, and asked for help.

Note that the descriptive clause starting with ‘which’ requires commas.
Use of ‘both’ and ‘only’

To avoid ambiguity with ‘only’, put it as close as possible to the word it qualifies:

   He loved only her.
   He only loved her.
   Only he loved her.

The word ‘both’ can often be left out of the sentence without any loss of meaning.

Split infinitives

Too long a gap between ‘to’ and the verb should be avoided to ensure the meaning is clear. In the two sentences below, the structure of second one is obviously better:

   Our purpose is to analytically, at whatever cost necessary, examine all the farming types.

   Our purpose is to examine analytically, at whatever cost necessary, all the farming types.

Clichés

Avoid clichés as much as possible. Examples commonly found are:

   this day and age
   burning issue
   at this moment in time
   wealth of information

Jargon

Do not overuse specialist terms. This can inhibit rather than promote the interchange of ideas beyond the particular discipline. Working language to some people is ‘noise’ to others so it is essential to be aware of the audience throughout the writing.

Gender issues

Use terms that apply to both sexes:

   ‘humans’, ‘persons’ or ‘people’ rather than ‘man’ or ‘Man’
   ‘staff’, ‘personnel’ or ‘workforce’, rather than ‘manpower’

Avoid using ‘he’ to represent both sexes, but do not over-use ‘he or she’. Avoid writing ‘he/she’ or ‘him/her’ if possible.

Using the plural often overcomes the difficulty:

   ‘Farmers are busy people’, not ‘The farmer is a busy man’.
Abbreviations

Abbreviations should be kept to a minimum; it should not be assumed that they will be easily understood by a reader from another discipline. However, some abbreviations are in common usage (see Appendix II and Style Guide for Technical Editors):

- et al.
- etc.
- NPK
- e.g.
- i.e.
- Mg

Do not begin a sentence with an abbreviation.

Grammar

The main concern of the technical report writer should be to write clearly and concisely so that readers have no difficulty in understanding the article. The odd grammatical error may not detract from an understanding of a particular phrase or sentence. However, there are instances where incorrect grammar may be the cause of misunderstanding or lack of clarity. In the following sections some of the likely errors are discussed under the eight parts of speech.

Nouns

Over-use of abstract nouns (formed from verbs and ending in ‘tion’) tends to make for long sentences and dull reading.

- conclusion, reduction, addition, exploration, production, interpretation

They are usually accompanied by passive, weak verbs. It is often better to replace them with an active verb.

- The addition of fertilizer was brought about manually.
- Fertilizer was added by hand.

Nouns can be used to modify other nouns but long strings of adjectival nouns are often difficult to understand:

- ‘At the water resources development plan board meeting . . .’ would be better expressed as ‘At the board meeting of the water resources development plan . . .’

The word ‘case’ is often over-used and can cause difficulties. For example, when the phrase ‘in the above cases’ is used the reader has to go back to find what the cases were.

Possible replacements are:

- in most cases
- in this case
- in all cases
- in no case
- in that case
- in the case of
- was the case
- usually, mostly
- here
- always
- never
- so
- for, in
- was so, was true
Verbs

Verbs can vary in number, tense, mood and voice.

Singular and plural
Subjects and their verbs should agree in number – singular subjects should have singular verbs and plural subjects plural verbs. Care is needed when the verb is far from its subject.

Compound subjects linked by ‘and’ should have plural verbs:

The director and the finance officer meet regularly to discuss . . .

Collective nouns (committee, government, club etc.) can use either a singular or plural verb depending on whether the emphasis is on the body as a whole or on individual members:

The board of directors meets twice a year.
The committee were not in agreement.

‘The committee was much smaller when I sat on it.’ not ‘The committee were much smaller when I sat on them.’

Organizations are usually considered to be singular:

The institute recruits . . .
The United Nations has resolved . . .

Singular subjects followed by prepositional phrases starting with ‘along with’, ‘together with’, ‘as well as’, in collaboration with’ take a singular verb:

The economist in collaboration with the social scientists has developed . . .

Unattached or dangling participles
Participles should be attached to their subjects. Check all words ending in ‘ed’ or ‘ing’ to see if they need a subject otherwise ambiguities can arise:

After standing in boiling water for half an hour, examine the flask.
On entering the field the bull charged.

Active or passive voice
The active voice is the natural voice, the one in which people usually speak or write, and its use is less likely to lead to verbosity and ambiguity. Turn a passive phrase to direct style whenever you can.

‘Williams reported that . . .’ rather than ‘It has been reported by Williams that . . .’

‘The technique involved spraying.’ rather than ‘Spraying was involved in the technique.’

‘The animals needed a mineral supplement.’ rather than ‘A mineral supplement was needed for the animals’.
The passive voice carries less emphasis but avoids the use of the personal pronoun which is desirable in formal writing. However, a report written entirely in the passive voice tends to read heavily.

_Tense_
Undisputed knowledge requires the present tense. An author usually writes about new work in the past tense. Other peoples' work is variously reported; the past tense may be most suitable.

The past tense (was, were) is used to describe completed observations and actions, and specific conclusions. The present tense (is, are) is used for directions, generalizations and statements of general validity.

'Would' is often used incorrectly for 'will'; 'would' is the past tense of 'will'.

He said he would be back tomorrow.

Would is also used to express the conditional mood:

They would have been in trouble if they had not taken advice.

_Pronouns_

When a pronoun such as 'it' or 'this' is used it should always be clear as to which of the preceding nouns or phrases it (the pronoun) refers. Repeat a word or phrase rather than risk being misunderstood.

If the baby does not thrive on raw milk, boil it.

The pronoun 'this' should not be used to refer to a vague concept which has been implied but not specifically stated:

This is one of the most common faults in report writing!

_Adjectives_

Try to avoid cliché adjectives:

| drastic steps | widespread concern |
| burning issue | bitter end |

Repetitious adjectives are superfluous:

| unexpected surprise | past history |
| actual fact | free gift |

Nouns can be used as adjectives:

| seed drill | disc plough |
| rice harvester | grain store |
Too many adjectives in a sentence can cause confusion. If there are more than about six, try another construction. Also, avoid the over-use of adjectives in a single phrase:

‘A new, labour-saving, seed drill box has been developed’, would be better written as: ‘A new type of labour-saving box has been developed for seed drills.’

**Adverbs**

Beware of misplaced adverbs. Always keep adverbs such as ‘nearly’, ‘only’, ‘even’, ‘quite’, etc. as near as possible to the words they are meant to modify:

He loved only her.
Only he loved her.

Be careful with vague adverbs which can detract from the intended effect:

- comparatively
- very
- relatively

Fairly
Rather

For example:

- rather lethal
- non-toxic insecticide
- fairly devastating

**Prepositions**

Most verbs can be used with more than one preposition, depending on the intended meaning, but some take only one:

‘I am tired of this course.’, **not** ‘I am tired with this course.’

Do not use ‘different than’ if you can use ‘different to’ or ‘different from’.

Care should be taken to choose the most appropriate preposition to convey the right meaning.

Use short expressions in preference to equivalent longer ones:

- ‘because’ instead of ‘as a consequence of’ or ‘for the reason that’
- ‘before’ instead of ‘prior to’

On the other hand do not omit prepositions where they are needed:

- Throw it out of the window.
- The seedlings were transplanted on Tuesday.

**Conjunctions**

Conjunctions (and, or, but, then) link words and phrases. It is quite in order to use conjunctions such as ‘but’ and ‘then’ at the beginning of a sentence.

The word ‘that’ can be used as a pronoun, adjective and adverb as well as a conjunction.
Exclamations or interjections

Exclamation marks are rarely used in technical reports. However they can indicate that something unexpected has happened:

...the opposite occurred and the yield increased by over 200%!

Punctuation

Commas

Never separate the subject of a sentence from its verb with a single comma; use either two commas for a parenthetical clause, or no commas. Both the following are correct:

The fruits, which were pear-shaped, weighed 200–250 g.
The fruits were pear-shaped and weighed 200–250 g.

Commas are usually used after adverbs such as ‘however’, ‘therefore’ and ‘nevertheless’ at the beginning of a sentence and around them within a sentence:

However, the results indicated otherwise.
The results, however, indicated otherwise.
Nevertheless, we were finally successful.
He, however, thought differently.

However, make sure that the intended meaning, or emphasis, of a sentence is not lost by sticking to the rule; common sense should be the guide:

He was compelled, however reluctantly, to accept the offer.
He was compelled, however, reluctantly to accept the offer.

Serial commas are sometimes essential to avoid ambiguity; also when some items in a list are paired:

green apples, red oranges, and bananas
avocado, banana and plantain, and citrus.

Semicolons and colons

Use a semicolon to separate closely related clauses or to separate parts of a complex series when the parts already include commas:

To err is human; to forgive, divine.

The tomatoes wilted; the beans, which had been planted early, died in August; and the peppers, a late variety, bore no fruit.

Use a colon to introduce a list, to separate clauses when there is a step forward from the first to the second, and to introduce quoted material:

Five disciplines were involved: agronomy, soil science, plant pathology, entomology and economics.
It was not easy: first we had to get appropriate funding.

He was recorded as saying: "This is a major achievement".

**Hyphens**

Use hyphens to clarify meaning:

- Too late for fat lovers to repent.
- re-form (form again)
- Too late for fat-lovers to repent.
- reform (improve)

Hyphens are rarely needed between adverbs (ending in 'ly') and the words they qualify:

- 'widely known fact' **not** 'widely-known fact'

Use a hyphen in a compound noun or adjective before, but not after, the word it qualifies:

- well-known method
- the method is well known
- 10-year-old boy
- the boy was 10 years old
- 10-g samples
- samples weighing 10 g

Hyphens are used in some chemical names, e.g. trans-2-bromocyclopentanol

**Apostrophes**

Apostrophes are used to indicate possession:

- the cat's whiskers
- James's

or elision of a letter:

- don't
- it's
- couldn't

They are best kept to a minimum.

Do not use apostrophes for the plural of dates:

- 1990s
- 1820s

Do not confuse the possessive 'its' with the contraction 'it's' (it is).

**Quotation marks**

Use single quotation marks to enclose the name of a cultivar the first time it is mentioned:

- 'Julie' mango
- 'Calypso' tomato

It is redundant to use the word cultivar (or cv.) and single quotation marks at the same time.
Capitalization

Capitalize common nouns when they form an essential part of a name, not when they stand alone:

Caroni River
Caribbean Insurance Company
Caribbean Agricultural Research and Development Institute

The river overflowed
The company was contracted to . . .
The institute has a mandate to . . .

Points of the compass are not capitalized except when they refer to a section of the country or a recognized geographical region:

South America
Northern Range

go south for 3 km
southern India

The first letter is capitalized for:

Genus, family and order but not species or subspecies:

Theobroma cacao

Trademarked names but not generic terms:

Benlate
benomyl

Any title of importance preceding a person’s name:

Prime Minister Jones
the ministers of agriculture

Organizations

Spell out an organization’s name in full at first mention with the acronym in parentheses, then abbreviate it in subsequent mentions:

... the International Institute of Tropical Agriculture (IITA) . . .

Do not use full stops in the abbreviation.

Some organizations omit the apostrophe in their name – follow the official usage.

Capitalize the name of the organization including the noun denoting the form of the organization:

Agronomy Society
Productive Farmers Union
4-H Club
Association of Caribbean States

Do not capitalize the general term when used alone:

the association
an organization of sheep farmers

international institutes
References

There are two systems in general usage:

- The Harvard or name-and-year system.

  In the text references are cited as:

  Adams and Seaton (1992) have suggested . . .  
  As already reported (Adams and Seaton 1991; Charles 1992) . . .  
  For more than two authors: Adams et al. (1992) . . .  

  In the reference list the names are given in alphabetical order.

- The sequential-numeric system in which numbers are used for citations.

  In the text references are cited as:

  As Williams\textsuperscript{1} has suggested . . .  or  As Williams (1) has suggested . . .  
  It has been reported\textsuperscript{20} that . . .  or  It has been reported (20) that . . .  

  For the list, references are either numbered and arranged in the order they are first referred to in text or the names in the reference list are arranged alphabetically and then numbered. (The numbers in this list are then used for citations in the text).

CARDI members of staff are requested to use the Harvard system.
5. PRESENTING NUMERICAL RESULTS

The aim of all agricultural research and development projects is to produce information that will improve some aspect of agriculture or marketing. The information must be technically correct and scientifically valid, which is why statistics – or more precisely, biometrics – is important. For results to be correct, trials and surveys must be designed properly. CARDI has resident biometricians available, but even in institutions without biometricians it is recommended, when designing a project, to consult a reference text to remind or inform of the methods available and the pitfalls to avoid. There are many such texts, three are particularly applicable and practical: Pearce et al. (1988), Lauckner and Fielding (1991), Poate and Daplyn (1993).

This section highlights some areas where problems occur when results are presented. It also gives a few tips on layout and makes certain recommendations to follow in order to present clear and uniform results. When writing a report remember to strike a balance between the type of reader and the need to demonstrate that good scientific principles have been followed.

Remember that because of the nature of scientific enquiry there can be no single correct way to present results, but it is possible (and even common) to be incorrect.

Reporting numbers

In reporting a number, the number of significant digits must be commensurate with the precision of the experimental method. Means should normally be quoted to the same accuracy (in terms of significant digits) as the observations from which the mean was calculated. Sometimes it may be necessary to add one more significant digit, e.g. when stating the number of animal births per litter.

However accurately the data are measured, for most purposes using three varying significant digits is usually adequate for quoting any statistic. Standard errors should usually be quoted to the same accuracy as the values they refer to, e.g. means. Sometimes it may be desirable to add one more digit as in Table 4 (see p. 31).

The Style Guide for Technical Editors (Walmsley 1996) deals with numbers and units in some detail.

Reporting statistical information

Experimental design

If the experimental design is well known (e.g. randomized complete block; completely randomized), then it is sufficient to specify the design type – usually in the ‘Materials and methods’ section. Details of the number of replications should also be given. Less well-known and ‘one-off’ designs should be described fully. The treatment structure should also be described; this is sometimes not clear in factorial experiments.
Standard errors

A table of means to which a statistical analysis applies should include one or more appropriate standard errors, together with degrees of freedom on which the standard error(s) are based. Examples of how to present standard errors and which standard errors to present are given below in the section dealing with ‘Tabular presentation’. Standard errors (and degrees of freedom) should also be quoted with the values of regression coefficients apart from the constant term, (see section on ‘Regression models’ below).

Please note that the symbol ± should not be used.

Least significant differences (LSDs) are sometimes used instead of standard errors. These should be used with caution. When an LSD is quoted it indicates that differences between calculated means are being tested, but more often an estimation is involved. LSDs are particularly inappropriate for treatment structures which are factorial or have quantitative (rather than qualitative) values.

Significance tests

Significance tests do not eliminate the need for standard errors. In these days of computer programs printing exact probabilities, it is much better to quote these exact probabilities (e.g. \( P = 0.0415 \)) rather than a particular test result (e.g. \( P \leq 0.05 \)).

Note that \( P \) (meaning probability) is written as a capital letter. If results of significance tests are to be used these must be in one of the forms indicated below:

\[
\begin{align*}
P &> 0.05 \text{ (for non-significance)} \\
P &\leq 0.01 \text{ (for significance)}
\end{align*}
\]

The usual probability levels for significance are 0.05, 0.01 and 0.001, but occasionally 0.1 may be used. The usual levels for non-significance are 0.05 and occasionally 0.1. The use of levels such as 0.01 and 0.001 for non-significance is not recommended.

Also not recommended is the use of stars, i.e. *, **, *** and the abbreviation, NS.

Multiple range tests have very limited practical use and certainly do not replace the need for standard errors.

Coefficient of variation

Coefficient of variation (CV) is among the least understood statistics. In many situations, e.g. when there are negative as well as positive values, and when the data are percentages, proportions, etc., the CV has no useful meaning. Also it should be remembered that an additive transformation (e.g. converting degrees Fahrenheit to degrees Celsius) will alter the CV.
Tabular presentation

(Tables 1–8 are included for illustration only and do not refer to a real situation)

Results for a simple treatment structure

A simple treatment structure is one where there is only one factor under consideration (i.e. not a factorial experiment). This can be presented as in Table 1.

Table 1  Mean plot yields for three cultivars of peanut grown in St Vincent

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albion</td>
<td>16.4</td>
</tr>
<tr>
<td>Barton</td>
<td>19.1</td>
</tr>
<tr>
<td>Cally</td>
<td>12.2</td>
</tr>
<tr>
<td>SED (16 df)</td>
<td>2.1</td>
</tr>
</tbody>
</table>

The standard error of difference (SED) between two means is given as an indication of the reliability of the means. Many other measures of reliability are sometimes given, but the ones that should be considered are the SED, the standard error of a mean (SEM) and the least significant difference (LSD).

The two types of standard error mentioned above (and note that there are also other types of standard error, so the abbreviation SE by itself is confusing) have their advantages and disadvantages in various situations. The SED measures the reliability of the difference between two mean values, whereas the SEM measures the reliability of a single mean value without reference to any other mean. Thus the SEM can be used to compare a mean with a fixed constant or standard value, and the SED compares one mean with another. The meaning of fixed constant should not be confused. The SEM is not suitable for comparing a value from one experiment with a value from a previous experiment. It can, however, be used to compare a mean value with a constant such as zero or a standard which has been observed over a number of years. In general it can be said that the SED is most useful when estimating the differences between treatments and the SEM when estimating the effect of a single treatment.

However, the SED can be a problem when there are unequal replicates, missing values and covariate adjustments. Then every pair of treatment means may have a different SED. Although every mean may have a different SEM it is relatively easy to present this as in Table 2.

The SEDs would best be presented as a symmetric matrix but this is likely to be confusing, especially if there are a large number of treatments.
Table 2  Mean weight gains of cattle fed on four different diets in Guyana

<table>
<thead>
<tr>
<th>Diet</th>
<th>Mean wt gain (g/day)</th>
<th>SEM (7 df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>245</td>
<td>26</td>
</tr>
<tr>
<td>Grass + molasses</td>
<td>493</td>
<td>41</td>
</tr>
<tr>
<td>Grass + molasses + supplement</td>
<td>517</td>
<td>40</td>
</tr>
<tr>
<td>Grass + supplement</td>
<td>350</td>
<td>37</td>
</tr>
</tbody>
</table>

Note that in Tables 1 and 2 the degrees of freedom (df) are quoted with the standard errors. These degrees of freedom are taken from the relevant error (or residual) sum of squares—**not** the treatment sum of squares. They should always be quoted as they very much affect the interpretation of the measure of reliability.

**Results for a factorial treatment structure**

When there are two factors in an experiment the results can be displayed as in Table 3.

It is important to note that in a table of this form more than one standard error will always have to be quoted. Note also that if the design is of the split-plot type, then the standard errors will usually not all be based on the same error degrees of freedom, so the different dfs must be clearly displayed to show which SEMs they refer to. Thus Table 3 is probably not based on an experiment that has split plots since only one df is quoted. In this type of experimental structure, SEMs may be preferable to SEDs as the concern is less likely to be with the differences between individual tabulated values, particularly in the body of the table. Note that with split-plot designs there is a further difficulty with SED as this is different for different pairs of interaction (body of table) means.

Table 3  Plot yields of ‘Calypso’ tomato grown under different fertilizer regimes (N and P) at Centeno, Trinidad

<table>
<thead>
<tr>
<th>Phosphate fertilizer (kg P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;/ha)</th>
<th>Yield (kg)</th>
<th>Nitrogen fertilizer (kg N/ha)</th>
<th>Mean yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>0</td>
<td>16.3</td>
<td>16.4</td>
<td>16.5</td>
</tr>
<tr>
<td>25</td>
<td>17.1</td>
<td>20.1</td>
<td>29.1</td>
</tr>
<tr>
<td>Mean yield (kg)</td>
<td>16.7</td>
<td>18.3</td>
<td>22.8</td>
</tr>
</tbody>
</table>

SEM (10 df) overall N means = 2.7
overall P means = 2.2
body of table = 3.8

Table 3 shows the results of an experiment with a large interaction. If the interaction is not significant, then consideration may be given to simply presenting the overall means and omitting the body of the table. On the other hand, if the interaction is large then the overall means may be considered not necessary – indeed they may not represent anything of interest.
With three or more factors there is often a problem of presentation. Three-way tables can be represented on two-dimensional paper, but it is not easy to see trends in such presentations. The problem becomes much more difficult with four or more factors.

There is a rule when interpreting factorial experiments to start at the bottom of the analysis of variance table and work upwards. In effect this means starting with the highest order of interactions. If a lower order interaction or main effect contains factors that have all been significant at a higher order then it should be disregarded. Correct application of this rule will often reduce consideration to a limited number of first order interactions and main effects which can then be presented as discussed above. If, however, second order and higher interactions are large, it is very difficult to give any general guidelines as the number of combinations of different possibilities is large. When such a situation arises it would be of advantage to discuss it with a statistician.

Results for many variables

Frequently more than one variable of interest is calculated or measured during an experiment. The researcher may or may not want to present the results for all of these based on a number of considerations such as type of presentation, importance of the variable, statistical significance (or perhaps more correctly, size of the effects), etc. For a simple experiment, one table can easily and clearly show the results for several variables (Table 4).

However, attempting to combine two or more variables in an interaction table, such as Table 2, is difficult without obfuscating the results.

Transformed data

Sometimes data from a variable have to be transformed or rescaled before a statistical process (e.g. analysis of variance) can be performed. This poses a problem with presentation since the transformed values make little sense biologically, but the untransformed or back-transformed means cannot be given a measure of reliability.

Table 4  Characteristics of four tomato cultivars grown at Union Experimental Station, St Lucia

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plot yield (kg)</th>
<th>Days to maturity</th>
<th>Number of fruits/plant</th>
<th>Stem length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acme</td>
<td>16.4</td>
<td>106</td>
<td>5.7</td>
<td>74</td>
</tr>
<tr>
<td>Burma</td>
<td>19.1</td>
<td>115</td>
<td>5.2</td>
<td>70</td>
</tr>
<tr>
<td>Castries</td>
<td>12.2</td>
<td>102</td>
<td>5.4</td>
<td>96</td>
</tr>
<tr>
<td>SED (16 df)</td>
<td>2.1</td>
<td>1.5</td>
<td>0.93</td>
<td>10.2</td>
</tr>
</tbody>
</table>

Usually the best compromise is to present the transformed means with the appropriate measure or measures of reliability, and then alongside them give the back-transformed means but without a measure of reliability (Table 5). This, of course may not be so simple when presenting two- or three-way tables; it is probably best in such cases to put the back-transformed means in parentheses after the transformed values.
Table 5  Yields of four yam cultivars grown at Dennery, St Lucia, 1986/1987

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean of square root (√x)</th>
<th>Back-transformed mean (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Lisbon</td>
<td>6.33</td>
<td>40.1</td>
</tr>
<tr>
<td>Oriental</td>
<td>6.29</td>
<td>39.6</td>
</tr>
<tr>
<td>Barrel</td>
<td>6.17</td>
<td>38.0</td>
</tr>
<tr>
<td>Red Bascombe</td>
<td>6.00</td>
<td>36.0</td>
</tr>
<tr>
<td>SED (9 df)</td>
<td>0.161</td>
<td></td>
</tr>
</tbody>
</table>

**Regression models**

There are limitations to the usefulness of the values of r and r², the coefficients of correlation and determination. Consider the data and linear regression fitted in Table 6. The r² value is very high but an examination of the data shows a non-linear relationship.

Table 6  Hypothetical data and linear model fitted

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>81</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

\[ y = -22 + 11x \]

\[ r^2 = 0.95 \]

Whenever a model is fitted the residuals should be examined by plotting them against the fitted (expected) values. If a model is suitable for the data these residuals should appear to be randomly scattered and form no pattern.

Also, the regression coefficients (with the exception of the constant) should be large compared with the standard errors of the coefficients. So, when presenting a regression model it is necessary to quote the standard errors of the coefficients (with residual df) as well as the r or r² value. There is no need to quote the standard error of the constant term.

It is cumbersome to present the residuals, but it could be mentioned in the text that the residuals were examined and this should assure any sceptical readers of the suitability of the model.
Survey results

Survey results are frequently presented in the form of one-way (Table 7) or two-way (Table 8) tables. Multi-way tables are also presented, but these need to be clear and not cluttered with values.

Table 7  Sheep farmers interviewed in the Scotland District of Barbados, according to age group

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Number of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 30</td>
<td>7</td>
</tr>
<tr>
<td>30–49</td>
<td>10</td>
</tr>
<tr>
<td>50–64</td>
<td>6</td>
</tr>
<tr>
<td>65 and over</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 8  The number of vegetable farms using fertilizer in the County of St George, Trinidad, grouped according to size

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>&lt; 0.5 ha</th>
<th>0.5–1 ha</th>
<th>&gt; 1 ha</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not use</td>
<td>13</td>
<td>9</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Do use</td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>18</td>
<td>8</td>
<td>43</td>
</tr>
</tbody>
</table>

Sometimes the numbers in these tables are augmented or replaced by percentages; this should not be done if the sample is small (30 or less). In a two-way table there is the additional problem of whether to give percentages of row totals, column totals or the overall total. If percentages of row or column totals are given the problem of small total observations will apply. For example, if there are only four farmers in a category, a table stating that 50% of these are female is unlikely to be a useful estimation of the females in the population to which that category refers. If percentages are quoted without actual numbers, the sample size must be indicated.

Values of test statistics such as chi squared should be quoted, if appropriate, with degrees of freedom and level of probability.

Table headings and format

Table headings must be self-explanatory; they must make sense without the reader having to refer to the text. However, they must also be as concise as possible. Remember to include all column headings and units where appropriate.
As a general rule, do not use vertical lines in the table and use as few horizontal lines as possible. (Vertical lines upset the diskette for the printer and anyway the layout may have to be altered to fit into the appropriate style).

**Graphs**

Graphs and histograms are often attractive alternatives to tables in presenting numerical results, they are particularly useful in showing trends and the relation between variables in the data presented, but some important points should be noted:

- Measures of reliability (with degrees of freedom) need to be shown where applicable.

- The scale of the x-axis variable (dependent variable) should be quantitative for graphs. Qualitative values are acceptable for histograms.

- The scale of the y-axis should be chosen so that treatments that are not similar can be easily distinguished.

- Graphs can be generated on a computer, but the software must be adequate to produce an acceptable camera-ready copy for the printer. If applicable SEs must be included or appended. Axes should be labelled horizontally and vertically (arranged to read upwards) with the appropriate unit in parentheses.

- Figure legends, like table headings, should be self-explanatory. They are placed at the **bottom** of the figure.

- If percentages are presented on graphs or histograms the same rules apply as described in the section on 'Survey results', p. 33.

- Remember that graphs or histograms do not contain as much information as tables as it is difficult to ascertain the value on the y-axis to more than a rough estimate, e.g. a value in a table of 32.7 will look like anything between 30 and 35 on many graphs. If readers need to know the results to some degree of accuracy use tables instead of graphs or histograms.

Figures 2, 3 and 4 show how results can be displayed graphically.
Figure 2  Suggested form of graphical presentation for a single factor experiment

Figure 3  Suggested form of graphical presentation for a two-factor experiment
Figure 4  Suggested form of histogram presentation
6. ILLUSTRATING PAPERS AND REPORTS

Good illustrations can often help to clarify the meaning of the text. Language is an inadequate medium for presenting some kinds of information; at its clearest it often fails to do what a drawing or a graph can do easily: average readers remember only 10% of what they read but 30% of what they see. Indeed, an illustration may be all that is required to present some information with only a brief reference in the text. This helps to make the report more concise.

There are two main types of illustration: those that help in the understanding of numerical data (tables, graphs, pie charts, histograms), and those that are descriptive (diagrams, flow charts, drawings, plans, maps, photographs). In deciding which type of illustration to use it is important to consider the objectives of the report, its purpose, readers, and what use will be made of it. It is also necessary to determine who will produce the actual illustrations and if in fact they can be produced. Can the author do it? Are specialist staff and equipment available? Should the job be done outside, and if so, what would it cost?

Tables

Do not include pages of tables of all the data you collected. Limit the number of tables to illustrate a point or finding. Keep them clear with explanatory column headings and give them titles that say what the table shows rather than what it is. For example: ‘Effect of phosphate fertilizer on yield of tomato growing on three different soils in Barbados’ rather than ‘Results of the fertilizer trial in Barbados’. The title should be self-explanatory and should make sense without the reader having to refer to the text. Remember to always include units, and use metric if possible. Tabular presentation is discussed in detail in Section 5.

Graphs

Graphs of various types can be used to present numerical results in an attractive manner. They must be simple and clear enough for readers to easily understand the message. With current software packages, visually pleasing graphics can be easily produced but take care to make the lettering and legends consistent in style. Figure legends always appear at the bottom of the figure. Don’t abbreviate words too heavily just to fit into a spreadsheet cell. Don’t try to show too many points on one graph; it may be better for the reader to split the information and make two. As with tables and their titles, figures and their legends must be independent of the text. Also ensure that relevant statistical information is included where required (see Section 5 for more information on this).

Diagrams

There are often cases in reports where information can best be adequately explained with the aid of a clear diagram. For example: life cycles of insects, working parts of machines, apparatus used in experiments, etc.
Draw them boldly and label the parts clearly and neatly. Diagrams should not be too complicated. If it is difficult to show all the information in one diagram, two or more should be used.

**Charts**

**Organizational charts** help to clarify relationships between people or departments within an organization.

**Flow charts** are often helpful in describing a series of actions which have taken place, or in recommending a course of action for the future.

**Drawings**

It is possible for simple line drawings to be done by the author, but more complicated drawings may need the services of a professional artist. Whereas diagrams are used to explain concepts and principles, drawings are used to show the reader what something actually looks like, e.g. an insect pest, a plant species, a piece of machinery.

Because they are realistic, drawings are more likely to arouse interest and are particularly useful in reports are intended to create an impression on the reader as well as convey information.

**Plans and maps**

Plans are helpful when describing field layouts of trial plots, livestock housing, irrigation systems, etc.

Maps are used for larger areas and may show the different soils, agro-climatic zones or the location of experimental sites.

Both plans and maps must be drawn to an appropriate scale. Maps should have a suitable system of shading and/or key.

**Photographs**

Photographs are often preferable to line drawings but may be more expensive. Both are used for the same purpose – to show the actual appearance of something described in the text. The use of photographs in support of scientific writing is accepted.

In selecting photographs, look for scientific interest, sharpness of focus, effective lighting and contrast and then consider whether or not a good line drawing or a diagram would not be better.

Colour is more expensive than black-and-white because the page has to pass through the printing machine four times for a full-colour picture, twice for a two-colour picture and only once for a black-and-white.
7. CHECK-LIST

As a last step before submitting the final version of the paper or report check the following:

• Consistency
• Nomenclature and spellings in text correspond to those in figures, maps and tables
• Authenticity and spelling of scientific names
• Tables and figures numbered correctly in order of their citation in the text
• Contents table gives headings and their hierarchy as in the text
• Pages numbered consecutively and properly
• Title, summary (abstract), and index terms appropriate
• Table titles and figure legends appropriate
• Each citation in text, tables, and legends listed in the reference list
• Each reference in the list cited at least once in the text, tables or legends
• Each citation in the reference list cited accurately, as shown by comparison with the original source, and in the form required by the journal
• Statistics properly addressed
• Acknowledgements
• Final version of report read at least twice – once against the pages from which it was typed and once for general review?
• Peer review by colleagues?
• Special requirements of the target journal met

A word of warning: the spellcheck facility in a word processor cannot help if you have used a wrong word by mistake. For example mistyping ‘not’ for ‘now’ can change the whole meaning of a sentence:

Pesticides are not used in large amounts in the Caribbean.

Pesticides are now used in large amounts in the Caribbean.
8. FURTHER READING AND REFERENCES


Lauckner F B and Fielding W J. 1991. Biometric notes for agricultural research in the Caribbean, 2nd edn. St Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute


Walmsley D. 1996. Style guide for technical editors. St Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute
APPENDIX I

ACCEPTABLE ABBREVIATIONS

AC  alternating current
a.i.  active ingredient
ad lib  *ad libitum* = at pleasure
a.m.  *ante meridiem* = before noon
amp  ampere
anon.  anonymous
Apr.  April
Aug.  August
av.  average

b.h.p.  brake horsepower
BP  boiling point

°C  degrees Celsius (Centigrade)
c.  *circa* = about
cal  gram calorie
Cal  kilogram calorie
cf.  *confer* = compare
c.i.f.  cost, insurance, freight
cm  centimetre
cm²  square centimetre
conc.  concentration
cont.  continued
CRD  completely randomized design
cv.  cultivar
CV  coefficient of variation
cwt  hundredweight
d  day
DAP  days after planting; di ammonium phosphate
DC  direct current
dep.t.  department
df  degrees of freedom
dry wt.  dry weight

ed.  editor
eds  editors

e.g.  *exempli gratia* = for example
et al.  *et alii* = and others
etc.  *et cetera* = and similar things
et seq.  *et sequentia* = and the following
ex  out of

°F  degrees Fahrenheit
Feb.  February
f.o.b.  free on board
Fig.  figure
Appendix I continued

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fl. oz</td>
<td>fluid ounce</td>
</tr>
<tr>
<td>ft</td>
<td>foot or feet</td>
</tr>
<tr>
<td>gal</td>
<td>gallon(s)</td>
</tr>
<tr>
<td>h</td>
<td>hour</td>
</tr>
<tr>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>HQ</td>
<td>headquarters</td>
</tr>
<tr>
<td>ibid.</td>
<td><em>ibidem</em> = in the same place</td>
</tr>
<tr>
<td>id.</td>
<td><em>idem</em> = the same</td>
</tr>
<tr>
<td>i.d.</td>
<td>inside diameter</td>
</tr>
<tr>
<td>i.e.</td>
<td><em>id est</em> = that is</td>
</tr>
<tr>
<td>Jan.</td>
<td>January</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram(s)</td>
</tr>
<tr>
<td>km</td>
<td>kilometre(s)</td>
</tr>
<tr>
<td>km²</td>
<td>square kilometre(s)</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatt</td>
</tr>
<tr>
<td>L</td>
<td>litre(s)</td>
</tr>
<tr>
<td>lb</td>
<td>pound(s)</td>
</tr>
<tr>
<td>LSD</td>
<td>least significant difference</td>
</tr>
<tr>
<td>m</td>
<td>metre(s)</td>
</tr>
<tr>
<td>m²</td>
<td>square metre(s), metre(s) squared</td>
</tr>
<tr>
<td>m³</td>
<td>cubic metre(s), metre(s) cubed</td>
</tr>
<tr>
<td>Mar.</td>
<td>March</td>
</tr>
<tr>
<td>min</td>
<td>minute</td>
</tr>
<tr>
<td>mL</td>
<td>millilitre(s)</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre(s)</td>
</tr>
<tr>
<td>MS</td>
<td>mean square</td>
</tr>
<tr>
<td>n.d.</td>
<td>no date, not dated</td>
</tr>
<tr>
<td>no.</td>
<td>number</td>
</tr>
<tr>
<td>NS</td>
<td>not significant</td>
</tr>
<tr>
<td>o.d.</td>
<td>outside diameter</td>
</tr>
<tr>
<td>op. cit.</td>
<td><em>opere citato</em> = in the work quoted</td>
</tr>
<tr>
<td>P</td>
<td>probability</td>
</tr>
<tr>
<td>P</td>
<td>phosphorus</td>
</tr>
<tr>
<td>p.</td>
<td>page</td>
</tr>
<tr>
<td>para(s).</td>
<td>paragraph(s)</td>
</tr>
<tr>
<td>pH</td>
<td>measure of acidity and alkalinity</td>
</tr>
<tr>
<td>p.m.</td>
<td><em>post meridiem</em> = after noon</td>
</tr>
<tr>
<td>pt</td>
<td>pint</td>
</tr>
<tr>
<td>pub.</td>
<td>published, published by, publisher</td>
</tr>
<tr>
<td>qt</td>
<td>quart</td>
</tr>
</tbody>
</table>
Appendix I continued

RCB  randomized complete block
RSS  residual sum of squares
s    second
SD   standard deviation
SE   standard error
SED  standard error of the difference between means
SEM  standard error of the mean(s)
SI   Système International (d’Unités)
SS   sum of squares

t    tonne(s), (1000 kg)
TSP  triple superphosphate
tsp.  teaspoonful(s)
tbsp. tablespoonful(s)

univ. university
vol.  volume
vs   versus
wk   week
yd   yard
yr   year
APPENDIX II

TERMS TO AVOID

The terms in the left-hand column are not wrong but the alternatives suggested in the right-hand column are preferred.

<table>
<thead>
<tr>
<th>Long or (sometimes) wrong</th>
<th>Better choice (often)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a majority of</td>
<td>most</td>
</tr>
<tr>
<td>a number of</td>
<td>few, several, many</td>
</tr>
<tr>
<td>accounted for by the fact that</td>
<td>because</td>
</tr>
<tr>
<td>and moreover</td>
<td>moreover</td>
</tr>
<tr>
<td>an order of magnitude</td>
<td>ten times</td>
</tr>
<tr>
<td>anticipate</td>
<td>expect</td>
</tr>
<tr>
<td>approximately</td>
<td>about</td>
</tr>
<tr>
<td>are of the same opinion</td>
<td>agree</td>
</tr>
<tr>
<td>as a consequence of</td>
<td>because</td>
</tr>
<tr>
<td>as already stated</td>
<td>[omit]</td>
</tr>
<tr>
<td>as can be seen from Figure 1 substance Z reduces itching</td>
<td>substance Z reduces itching (Figure 1)</td>
</tr>
<tr>
<td>as far as these experiments are concerned, they show</td>
<td>these experiments show</td>
</tr>
<tr>
<td>as of now</td>
<td>now, from now on</td>
</tr>
<tr>
<td>as regards this species, it</td>
<td>this species is</td>
</tr>
<tr>
<td>as to whether</td>
<td>whether</td>
</tr>
<tr>
<td>as yet</td>
<td>yet</td>
</tr>
<tr>
<td>at a later date</td>
<td>later</td>
</tr>
<tr>
<td>at some future time</td>
<td>try</td>
</tr>
<tr>
<td>attempt</td>
<td>[omit]</td>
</tr>
<tr>
<td>at the end of the day</td>
<td>now</td>
</tr>
<tr>
<td>at the present moment</td>
<td>now</td>
</tr>
<tr>
<td>at this point in time</td>
<td>bright yellow</td>
</tr>
<tr>
<td>bright yellow in colour</td>
<td>by, with</td>
</tr>
<tr>
<td>by means of</td>
<td>damaged</td>
</tr>
<tr>
<td>caused damage to commence</td>
<td>begin, start</td>
</tr>
<tr>
<td>completely filled</td>
<td>filled</td>
</tr>
<tr>
<td>consensus of opinion</td>
<td>consensus</td>
</tr>
<tr>
<td>considerable amount of</td>
<td>much</td>
</tr>
<tr>
<td>considerable number of</td>
<td>many, most</td>
</tr>
<tr>
<td>decreased number of</td>
<td>fewer, less</td>
</tr>
<tr>
<td>decreased relative to</td>
<td>less than, lower than</td>
</tr>
<tr>
<td>definitely proved</td>
<td>proved</td>
</tr>
<tr>
<td>despite the fact that</td>
<td>although</td>
</tr>
<tr>
<td>due to the fact that</td>
<td>because</td>
</tr>
<tr>
<td>during the course of</td>
<td>during, while</td>
</tr>
<tr>
<td>during the time that</td>
<td>while</td>
</tr>
<tr>
<td>elevated</td>
<td>raised, higher, more</td>
</tr>
<tr>
<td>employ</td>
<td>use</td>
</tr>
<tr>
<td>encountered</td>
<td>met</td>
</tr>
</tbody>
</table>
### Appendix II continued

<table>
<thead>
<tr>
<th>Long or (sometimes) wrong</th>
<th>Better choice (often)</th>
</tr>
</thead>
<tbody>
<tr>
<td>equivalent as far as acceptability is concerned</td>
<td>equally acceptable</td>
</tr>
<tr>
<td>fewer in number</td>
<td>fewer</td>
</tr>
<tr>
<td>following (e.g. an event)</td>
<td>after</td>
</tr>
<tr>
<td>for the reason that</td>
<td>because</td>
</tr>
<tr>
<td>from the standpoint of</td>
<td>according to</td>
</tr>
<tr>
<td>fully cognizant of the fact that</td>
<td>aware that</td>
</tr>
<tr>
<td>goes under the name of</td>
<td>is called</td>
</tr>
<tr>
<td>has the capability of</td>
<td>can, is able to</td>
</tr>
<tr>
<td>having regard to</td>
<td>about</td>
</tr>
<tr>
<td>if conditions are such that</td>
<td>if</td>
</tr>
<tr>
<td>in a considerable number of cases</td>
<td>often</td>
</tr>
<tr>
<td>in all cases</td>
<td>always, invariably</td>
</tr>
<tr>
<td>in close proximity to</td>
<td>close to</td>
</tr>
<tr>
<td>in connection with</td>
<td>about, concerning</td>
</tr>
<tr>
<td>in excess of</td>
<td>more than, above</td>
</tr>
<tr>
<td>in order to</td>
<td>to</td>
</tr>
<tr>
<td>in regard to, in relation to, in respect of,</td>
<td>use: in, for, or with;</td>
</tr>
<tr>
<td>in the case of, etc.</td>
<td>or omit, as appropriate</td>
</tr>
<tr>
<td>in the event that</td>
<td>if</td>
</tr>
<tr>
<td>in the present communication</td>
<td>here, in this paper</td>
</tr>
<tr>
<td>in view of the fact that</td>
<td>because</td>
</tr>
<tr>
<td>integral part</td>
<td>part</td>
</tr>
<tr>
<td>it is of interest to note that</td>
<td>[omit]</td>
</tr>
<tr>
<td>it may, however, be noted that</td>
<td>but</td>
</tr>
<tr>
<td>join together</td>
<td>join</td>
</tr>
<tr>
<td>large numbers of</td>
<td>many</td>
</tr>
<tr>
<td>lazy in character</td>
<td>lazy</td>
</tr>
<tr>
<td>major breakthrough</td>
<td>breakthrough</td>
</tr>
<tr>
<td>mass media</td>
<td>media</td>
</tr>
<tr>
<td>methodology</td>
<td>methods</td>
</tr>
<tr>
<td>multiple</td>
<td>several, different</td>
</tr>
<tr>
<td>my personal opinion</td>
<td>my opinion</td>
</tr>
<tr>
<td>on the basis of</td>
<td>because, by, from</td>
</tr>
<tr>
<td>owing to the fact that</td>
<td>because</td>
</tr>
<tr>
<td>oval in shape</td>
<td>oval</td>
</tr>
<tr>
<td>paradigm</td>
<td>example, pattern</td>
</tr>
<tr>
<td>parameter</td>
<td>index, criterion, measure, value</td>
</tr>
<tr>
<td>permeate throughout</td>
<td>permeate</td>
</tr>
<tr>
<td>penetrate into</td>
<td>permeate</td>
</tr>
<tr>
<td>pertaining to</td>
<td>on, about</td>
</tr>
<tr>
<td>plethora</td>
<td>too many</td>
</tr>
<tr>
<td>prior to</td>
<td>before</td>
</tr>
<tr>
<td>reported to the effect that</td>
<td>reported that</td>
</tr>
<tr>
<td>similar in every detail</td>
<td>the same</td>
</tr>
<tr>
<td>a serious malfunction has occurred</td>
<td>the system has failed</td>
</tr>
<tr>
<td>in the system</td>
<td></td>
</tr>
<tr>
<td>subsequent to</td>
<td>after</td>
</tr>
<tr>
<td>take into consideration</td>
<td>consider</td>
</tr>
<tr>
<td>Long or (sometimes) wrong</td>
<td>Better choice (often)</td>
</tr>
<tr>
<td>----------------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>temporary reprieve</td>
<td>reprieve</td>
</tr>
<tr>
<td>terminate</td>
<td>end</td>
</tr>
<tr>
<td>the test in question</td>
<td>this test</td>
</tr>
<tr>
<td>the tests have not as yet</td>
<td>the tests have not</td>
</tr>
<tr>
<td>the treatment having been performed</td>
<td>after treatment</td>
</tr>
<tr>
<td>there can be little doubt that this is</td>
<td>this is probably</td>
</tr>
<tr>
<td>there is, there are</td>
<td>[often unnecessary; reword the sentence]</td>
</tr>
<tr>
<td>there is a lot of care that goes into</td>
<td>much care goes into</td>
</tr>
<tr>
<td>thorough investigation</td>
<td>investigation</td>
</tr>
<tr>
<td>throughout the whole of the book</td>
<td>throughout the book</td>
</tr>
<tr>
<td>to an extent equal to that of X</td>
<td>as much as X</td>
</tr>
<tr>
<td>two equal halves</td>
<td>halves</td>
</tr>
<tr>
<td>upon</td>
<td>on</td>
</tr>
<tr>
<td>utilize</td>
<td>use</td>
</tr>
<tr>
<td>very, quite, rather, and other vague qualifiers</td>
<td>[omit]</td>
</tr>
<tr>
<td>viz.</td>
<td>namely</td>
</tr>
<tr>
<td>when and if</td>
<td>if</td>
</tr>
<tr>
<td>whether or not</td>
<td>whether</td>
</tr>
<tr>
<td>with reference to, with regard to</td>
<td>about [or omit]</td>
</tr>
</tbody>
</table>
# APPENDIX III

## CONVERSION FACTORS FOR METRIC AND IMPERIAL UNITS

<table>
<thead>
<tr>
<th>To convert Column 1 into Column 2 multiply by:</th>
<th>Column 1, metric unit</th>
<th>Column 2, imperial unit</th>
<th>To convert Column 2 into Column 1 multiply by:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.621</td>
<td>kilometre, km</td>
<td>mile, mi</td>
<td>1.609</td>
</tr>
<tr>
<td>1.094</td>
<td>metre, m</td>
<td>yard, yd</td>
<td>0.914</td>
</tr>
<tr>
<td>3.281</td>
<td>metre, m</td>
<td>foot, ft</td>
<td>0.305</td>
</tr>
<tr>
<td>0.0328</td>
<td>centimetre, cm</td>
<td>foot, ft</td>
<td>30.480</td>
</tr>
<tr>
<td>0.394</td>
<td>centimetre, cm</td>
<td>inch, in</td>
<td>2.540</td>
</tr>
<tr>
<td>0.0394</td>
<td>millimetre, mm</td>
<td>inch, in</td>
<td>25.400</td>
</tr>
<tr>
<td>10</td>
<td>nanometre, nm</td>
<td>Angstrom, Å</td>
<td>0.100</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.471</td>
<td>hectare, ha</td>
<td>acre</td>
<td>0.405</td>
</tr>
<tr>
<td>247.110</td>
<td>square kilometre, km²</td>
<td>acre</td>
<td>0.00405</td>
</tr>
<tr>
<td>0.386</td>
<td>square kilometre, km²</td>
<td>square mile, mi²</td>
<td>2.590</td>
</tr>
<tr>
<td>0.000247</td>
<td>square metre, m²</td>
<td>acre</td>
<td>4050.0</td>
</tr>
<tr>
<td>0.836</td>
<td>square metre, m²</td>
<td>square yard, yd²</td>
<td>1.196</td>
</tr>
<tr>
<td>10.764</td>
<td>square metre, m²</td>
<td>square foot, ft²</td>
<td>0.0929</td>
</tr>
<tr>
<td>0.1550</td>
<td>square centimetre, cm²</td>
<td>square inch, in²</td>
<td>6.451</td>
</tr>
<tr>
<td>0.00155</td>
<td>square millimetre, mm²</td>
<td>square inch, in²</td>
<td>645.</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00973</td>
<td>cubic metre, m³</td>
<td>acre-inch, acre-in</td>
<td>102.8</td>
</tr>
<tr>
<td>35.315</td>
<td>cubic metre, m³</td>
<td>cubic foot, ft³</td>
<td>0.0283</td>
</tr>
<tr>
<td>1.308</td>
<td>cubic metre, m³</td>
<td>cubic yard, yd³</td>
<td>0.765</td>
</tr>
<tr>
<td>0.061</td>
<td>cubic centimetres, cm³</td>
<td>cubic inch, in³</td>
<td>16.387</td>
</tr>
<tr>
<td>1.057</td>
<td>litre, L (10⁻³ m³)</td>
<td>US quart, qt</td>
<td>0.946</td>
</tr>
<tr>
<td>0.88</td>
<td>litre, L</td>
<td>imperial quart, qt</td>
<td>1.136</td>
</tr>
<tr>
<td>0.0353</td>
<td>litre, L</td>
<td>cubic foot, ft³</td>
<td>28.3</td>
</tr>
<tr>
<td>61.023</td>
<td>litre, L</td>
<td>cubic inch, in³</td>
<td>0.0164</td>
</tr>
<tr>
<td>2.11</td>
<td>litre, L</td>
<td>US pint, pt</td>
<td>0.473</td>
</tr>
<tr>
<td>1.75</td>
<td>litre, L</td>
<td>imperial pint, pt</td>
<td>0.570</td>
</tr>
<tr>
<td>0.265</td>
<td>litre, L</td>
<td>US gallon, gal</td>
<td>3.785</td>
</tr>
<tr>
<td>0.220</td>
<td>litre, L</td>
<td>imperial gallon, gal</td>
<td>4.546</td>
</tr>
<tr>
<td>33.78</td>
<td>litre, L</td>
<td>US fluid ounce, fl oz</td>
<td>0.0296</td>
</tr>
<tr>
<td>0.0352</td>
<td>millilitre, mL</td>
<td>imperial fluid ounce, fl oz</td>
<td>28.4</td>
</tr>
</tbody>
</table>
### Appendix III continued

<table>
<thead>
<tr>
<th>To convert Column 1, metric unit</th>
<th>Column 2, imperial unit</th>
<th>To convert Column 2 into Column 1 multiply by:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00220 gram, g</td>
<td>pound, lb</td>
<td>454.</td>
</tr>
<tr>
<td>0.0352 gram, g</td>
<td>ounce, oz</td>
<td>28.4</td>
</tr>
<tr>
<td>2.205 kilogram, kg</td>
<td>pound, lb</td>
<td>0.454</td>
</tr>
<tr>
<td>0.01 kilogram, kg</td>
<td>quintal, q</td>
<td>100.</td>
</tr>
<tr>
<td>0.0011 kilogram, kg</td>
<td>short ton (2000 lb), ton</td>
<td>907.</td>
</tr>
<tr>
<td>0.001 kilogram, kg</td>
<td>long ton (2240 lb), ton</td>
<td>1016.</td>
</tr>
<tr>
<td>0.0197 kilogram, kg</td>
<td>hundredweight, cwt</td>
<td>50.8</td>
</tr>
<tr>
<td>1.102 megagram, Mg (tonne)</td>
<td>short (US) ton</td>
<td>0.907</td>
</tr>
<tr>
<td>1.102 tonne, t</td>
<td>short (US) ton</td>
<td>0.907</td>
</tr>
<tr>
<td><strong>Yield and rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.893 kilogram per hectare, kg/ha</td>
<td>pound per acre, lb/acre</td>
<td>1.121</td>
</tr>
<tr>
<td>0.00797 kilogram per hectare, kg/ha</td>
<td>hundredweight per acre</td>
<td>125.480</td>
</tr>
<tr>
<td>0.446 tonne per hectare, t/ha</td>
<td>short ton per acre, ton/acre</td>
<td>2.240</td>
</tr>
<tr>
<td>0.398 tonne per hectare, t/ha</td>
<td>long ton per acre, ton/acre</td>
<td>2.516</td>
</tr>
<tr>
<td>0.107 litre per hectare, L/ha</td>
<td>US gallon per acre, gal/acre</td>
<td>9.350</td>
</tr>
<tr>
<td>0.089 litre per hectare, L/ha</td>
<td>imp. gallon per acre, gal/acre</td>
<td>11.23</td>
</tr>
<tr>
<td>0.428 litre per hectare, L/ha</td>
<td>US quart per acre, qt/acre</td>
<td>2.337</td>
</tr>
<tr>
<td>0.356 litre per hectare, L/ha</td>
<td>imp. quart per acre, qt/acre</td>
<td>2.806</td>
</tr>
<tr>
<td>0.856 litre per hectare, L/ha</td>
<td>US pint per acre, pt/acre</td>
<td>1.168</td>
</tr>
<tr>
<td>0.710 litre per hectare, L/ha</td>
<td>imp. pint per acre, pt/acre</td>
<td>1.408</td>
</tr>
<tr>
<td>2.24 metre per second, m/s</td>
<td>mile per hour, mph</td>
<td>0.447</td>
</tr>
<tr>
<td>0.621 kilometre per hour, km/h</td>
<td>mile per hour, mph</td>
<td>1.609</td>
</tr>
<tr>
<td>0.00891 cubic metre per hour, m³/h</td>
<td>cubic feet per second, ft³/s</td>
<td>101.9</td>
</tr>
<tr>
<td>4.40 cubic metre per hour, m³/h</td>
<td>US gallons per minute, gal/min</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/5 °C + 32 Celsius, °C</td>
<td>Fahrenheit, °F</td>
<td>5/9 (°F - 32)</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.223 kilogram per cm²</td>
<td>pound per square inch</td>
<td>0.070</td>
</tr>
<tr>
<td>9.90 megapascal, MPa</td>
<td>atmosphere</td>
<td>0.101</td>
</tr>
<tr>
<td>10. megapascal, MPa</td>
<td>bar</td>
<td>0.1</td>
</tr>
<tr>
<td>0.0209 pascal, Pa</td>
<td>pound per square ft, lb/ft²</td>
<td>47.9</td>
</tr>
<tr>
<td>0.000145 pascal</td>
<td>pound per square inch, lb/in²</td>
<td>6900.</td>
</tr>
</tbody>
</table>