

*Scientific
writing for
agricultural
research
scientists*

a training reference manual

Paul Stapleton
Anthony Youdeowei
Joy Mukanyange
Helen van Houten

Scientific writing for agricultural research scientists

a training reference manual

Paul Stapleton

International Plant Genetic Resources Institute, Italy

Anthony Youdeowei

West Africa Rice Development Association, Côte d'Ivoire

Joy Mukanyange

Technical Centre for Agricultural and Rural Cooperation,
Netherlands

Helen van Houten

International Centre for Research on Agroforestry, Kenya

Published by the West Africa Rice Development Association
(WARDA) in collaboration with the Technical Centre for
Agricultural and Rural Cooperation (CTA)

© WARDA/CTA, 1995

ISBN 92 9113 0699

Contents

Acknowledgments. . .	iv
Introduction. . .	1
Unit 1	Avenues of communication in science. 3
Unit 2	Choosing a journal. 8
Unit 3	The IMRAD form of presenting research papers. 11
Unit 4	Writing a research paper 20
Unit 5	Scientific style and English in a research paper..... 31
Unit 6	Numbers, units, abbreviations and nomenclature 47
Unit 7	References..... 63
Unit 8	Using tables to present research results 73
Unit 9	Using illustrations to present research results..... 78
Unit 10	Oral presentation of research results..... 88
Unit 11	Using posters to present research results 91
Unit 12	Writing proposals and reports..... 96
Unit 13	The importance of the media and popular writing..... 101
Unit 14	Basic facts about photography 109
Unit 15	Publishing ethics 120
Recommended reading. . .	125
Index. . .	127

Acknowledgements

THIS BOOK IS THE RESULT of a successful collaborative effort by many individuals, organizations and donor agencies. Members of the team who first developed the training course curriculum were Jacques Faye (WAFSRN), Michelle Jeanguyot (CIRAD), Joseph Menyonga (SAFGRAD), Joy Mukanyange (CTA), Mildred Otu-Bassey (AASE), Paul Stapleton (IBPGR—now IPGRI), C. Tahiri-Zagret (University of Abidjan), Sidney Westley (ICRAF) and Anthony Youdeowei (WARDA). Special thanks go to their institutions for granting their staff permission to participate in the expert consultation and to the Ford Foundation for supporting the consultation.

Funding for the series of group training courses has been provided by the following organizations, to which the authors and trainees are deeply indebted: the Technical Centre for Agricultural and Rural Cooperation (CTA), the Netherlands; the International Foundation for Science (IFS), Sweden; the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France; the Agence de Coopération Culturelle et Technique (ACCT), France; and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Germany.

We are also very grateful to Joan Baxter of ICRAF for writing unit 13, 'The importance of the media and popular writing', to Kellen Kebaara, also of ICRAF, for meticulously editing and proofreading the final manuscript, and to Susan MacMillan of the International Livestock Research Institute for valuable criticism.

Introduction

THE NEED FOR TRAINING agricultural research scientists in Africa in the procedures and techniques for writing and publishing the results of their research has been independently identified by a variety of institutions, organizations and agricultural research and development networks throughout the region.

Early in 1990, the West Africa Rice Development Association (WARDA) and the West Africa Farming Systems Research Network (WAFSRN), coordinated by the Semi-Arid Food Grains Research and Development Project (SAFGRAD), met in Bouaké, Côte d'Ivoire, to discuss this training need and to formulate a joint effort to organize a series of training courses in scientific writing for agricultural research scientists in West Africa. This discussion led to an expert consultation in Ouagadougou, Burkina Faso, supported by the Ford Foundation and the Technical Centre for Agricultural and Rural Cooperation (CTA) in 1991. At this consultation, the target audience for these courses was defined, details of a training course curriculum and pattern of instruction were elaborated and a 3-year training project was developed. An important component of this project was the development and publication of a training manual to accompany these courses.

Group training started in Togo in 1991 and has continued every year, with the International Centre for Research in Agroforestry (ICRAF) collaborating from 1994. Our aim in these training courses is to achieve the following:

- strengthen scientific communication capabilities of agricultural research scientists in Africa
- encourage and promote a culture of scientific publishing among agricultural researchers

2 □ *scientific writing for agricultural research scientists*

- create a community of agricultural researchers who regularly communicate with one another and thereby minimize scientific isolation
- share experiences on problems encountered by researchers in publishing their research

During the training sessions, we focus attention on analysing the structure of a scientific research paper, planning the writing process, observing style and ethics in scientific writing, correctly citing bibliographic references, and presenting agricultural research results orally.

We adopt a multifaceted approach, which includes a combination of lectures, a complete interactive mode between trainers and trainees and among the trainees themselves, experiential learning and feedback, hands-on practical exercises, working-group activities, group discussion and critique, demonstrations, and the use of video recording.

This training reference manual has been developed and field tested as we have implemented this training project. In writing it we have endeavoured to incorporate the procedures for citing references that are specified in the revised Council of Biology Editors manual, *Scientific style and format*, published in 1994. We hope that it will serve as a guide to young agricultural research scientists who are starting their research and scientific publishing careers.

The manual can also be used by resource people preparing curricula and course notes for in-country training courses in scientific writing. In such a case, it is strongly recommended that the course curriculum be adapted to the particular training needs of the target audience by selecting units and topics from this book and giving the necessary emphasis to ones of particular interest to the group being trained.

1

Avenues of communication in science

Purpose

This unit will help training participants to:

- ❑ recognize the different avenues of communication within scientific research
- ❑ choose the avenue most suitable for the audience they are addressing
- ❑ be aware that they must adjust their writing style to suit the needs of their audience

MANY AVENUES OF COMMUNICATION are open to scientists who want to deliver information on their research and results. Vehicles for addressing scientific and general audiences include the following:

Research communications

research journals
research reviews
conference papers
Theses
book chapters
annual reports

Extension and popular communications

extension manuals
newspaper reports
magazine articles
radio broadcasts
films and video

newsletters	audiovisual shows
project proposals	practical demonstrations
lectures	handbills
meetings with individuals	cartoons
leaflets	photographs
posters	

Each of these vehicles has specific uses. Showing a cartoon strip would probably be inappropriate at an international conference and delivering a research paper would be useless to most farmers. Effective communication depends on delivering the right message in the right way to the right audience. Many excellent scientists do not write well because they do not take the time to try to communicate skillfully. With a little effort, all scientists can make their work more comprehensible to a general audience and can learn to adapt their presentations to given media.

Every research scientist should expect to have to write for each kind of research communication listed above sometime during their career. The extension and popular material, on the other hand, is more often produced by extension or media professionals.

This unit concerns itself with avenues of communication within the research field.

Research journal

The chief purpose of a research journal is to publish scientific papers that communicate new and original information to other scientists. The research paper takes a hypothesis that has been tested by experimental methods to come to conclusions. Research journals are the most common organ of communication in science. There are two main types of readers of research papers. One is the specialist in the field who will want to read the entire paper to partake of all its information. The other is the casual reader, who will be interested mainly in the results, or perhaps the experimental methodology employed, as background to the reader's own work. Thus, two different audiences exist even for a single type of highly specialized communication.

Research review

A review article is like an extended version of the discussion in a research article. An essential feature of a review is that the reader is led to the cutting edge of a given area of research. A good review gathers together all important work on a topic, but it is not simply a catalogue of facts. It synthesizes work done; it analyses and interprets existing facts and theories within a particular field.

Conference paper

A paper delivered orally at a conference is necessarily short. It confines itself to a brief presentation of the objectives and the methods of the work and the results, the interpretation of which may be preliminary. Its clearly stated points can be brought out in the discussion. A revised version of the oral presentation, made for publication of the proceedings, can be more thorough.

Thesis or dissertation

The telling characteristic of a thesis or dissertation is its length. A work of this type is the written evidence of sustained research done over a considerable period, usually 2–4 years. It generally contains an extensive review of the literature as well as the results of several experiments, all of which were aimed at testing a single hypothesis.

Book chapter

Chapters of scientific works tend to synthesize information about a particular subject. A book chapter rarely sets out a fundamental hypothesis.

Annual report

An annual report describes work completed in any 12-month period. The intent is not so much to conclusively prove a hypothesis but rather to spell out objectives, describe activities and justify budget expenditure for a piece of research undertaken in the year.

Newsletter

The purpose of a scientific newsletter is to disseminate information of interest to its readers quickly and in a readily digestible format. Thus the content of most contributions carries little emphasis on justification or methodology. Most newsletters address a general readership and should not be used as a substitute for publication of research results in refereed journals.

Project proposal

A project proposal justifies a programme of work and states the expected outputs and clearly defined objectives of that programme.

Audiences

Readers of agricultural and related research fall into different groups. The most common audience groups include—

- | | |
|--|--|
| <input type="checkbox"/> researchers within a specific field of research | <input type="checkbox"/> policymakers |
| <input type="checkbox"/> researchers with a peripheral interest in a field of research | <input type="checkbox"/> donor agents |
| <input type="checkbox"/> research managers | <input type="checkbox"/> members of government research committees |
| <input type="checkbox"/> university lecturers | <input type="checkbox"/> commercial business people |
| <input type="checkbox"/> extension agents | <input type="checkbox"/> technicians |
| <input type="checkbox"/> farmers | <input type="checkbox"/> students |

Intent of a research communication

Research communications have different *intents*. That is, they take the same basic information and treat it in different ways to convey the same message to different audiences. The technical content of a given message will differ according to the audience, as shown in Table 1.1.

The way in which the technical content of any publication is packaged is crucial to its understanding by an audience. If the person reading the material cannot understand it, the effect of the work is lost entirely.

Table 1.1. Technical content and audience of different types of science writing

Avenue	Technical content (1=high, 6=low)	Audience
Research papers	1	researchers within and outside the discipline, university students and lecturers, senior extension workers, research managers
Book chapters		
Technical	2	same as research papers
General	4 or 5	technicians, students, extension workers
Research reviews	2 to 4	researchers outside a discipline, university students and lecturers, extension workers, commercial interests
Theses	1	researchers within a discipline, university students and lecturers
Conference papers	2 or 3	researchers within and outside a field, university students and lecturers, research managers
Annual reports		
Highlights	3 or 4	donors, policymakers, government committees, extension agents, institute directors
Main text	1	researchers within and outside a field, university students and lecturers, research managers
Newsletters	5 or 6	researchers within and outside a field, students and lecturers. extension agents, policymakers, expert farmers
Project proposals	2	donors, policymakers, research managers, institute directors

Choosing a journal

Purpose

This unit will help training participants to:

- evaluate a journal's policy, scope and content
- define the special requirements for producing an article for publication

BEFORE YOU START planning an article for publication, you should target a journal for your paper. Your choice of journal will often influence the format and style of your article. Different journals have different styles and different rules of presentation for the material they publish.

Most journals today receive many more papers than they can possibly publish, and the best journals have a high rejection rate. If you are a beginning writer, you stand a better chance of having your paper accepted if you select a less prestigious journal. Should you try an international journal or a local or regional one? It probably requires more effort to write a paper for an international journal, but the rewards are also greater because greater numbers of readers will come across your paper if it appears in an international journal. On the other hand, local journals need the support of good scientists and writers to increase their value and readership.

You must weigh these matters. Is your paper of sufficient merit and of sufficient interest to a broad audience to send it to the very best journal? If not, it is better to send it to a less well-known journal, where you may have a better chance of getting it accepted.

What are the scope and aims of the journal?

A statement of a journal's purpose and scope is usually printed on the inside of the cover of the journal. Read it carefully. There is no point in sending a research paper to a journal that publishes only reviews; nor is there any point in sending a theoretical paper to a journal that publishes only practical research.

How often is the journal published?

Scientific publishing is usually a slow process, and a journal that is published twice a year will take much longer to publish a paper than a journal that appears once every two weeks. You have to ask yourself, 'Will a 15-month publication time affect the relevance of my article?' If the paper should be published quickly, send it to a journal that can publish it quickly; if rapid publication is not essential, the editors of a fortnightly journal are likely to reject your paper in any case.

What type of articles does the journal publish?

Many journals require a specific format for the articles they publish. If your article does not fit this format, the paper may be rejected. For example, if your paper when printed will be 20 pages long and the journal publishes papers only up to 5 pages, your paper will be rejected—not because of its scientific content but simply because your format did not match that of the journal.

Are there any conditions to submitting to the journal?

In some journals, one of the authors must be a member of the society that publishes the journal. Sometimes certain types of statistical analysis must be used, or the experiments must have been repeated a number of times. Many journals have page charges—that is, you have to pay the journal to publish the paper. The charges are based on the number of pages that comprise the published paper. These charges can be extremely high. Some journals even expect money to be sent with the manuscript to cover the cost of

considering the paper. Note, however, that some journals with page charges waive this fee for authors from certain countries. Look for these conditions in the journal's 'Instructions to authors'.

Does your paper have any special requirements?

You might have a series of photomicrographs or electron micrographs that are important to your paper. You should then look for a journal that prints such photographs well. Many journals do not print colour photographs, because they are expensive to reproduce. If your paper requires them, you will have to find a journal that will accept them, but note that many journals that print colour photographs charge the author for the colour.

Journal style

Once you have decided on a journal to which you will submit your paper, you should start to prepare your manuscript in that journal's style and format. Most journals publish a detailed guide to contributors, or 'Instructions to authors', usually in the first issue of the year but sometimes as a separate booklet. Write to the journal editor requesting these instructions or photocopy them from an issue in your local library. If a person other than yourself will type your paper, make sure that the typist also reads and follows the journal's instructions and specifications.

3

The IMRAD form of presenting research papers

Purpose

This unit will help training participants to:

- ❑ define the IMRAD format
- ❑ recognize what belongs in each section of a research paper

SCIENTIFIC RESEARCH IS an organized and logical activity, and therefore reporting research must also be well organized and logical.

This unit provides the basic elements of the procedures and techniques that will facilitate reporting research results. Through regular practice, using the techniques explained here, you can gradually improve your skills in writing research papers.

Writing scientific papers

One common question researchers often ask is, 'Why should scientists write research papers?' The many reasons include helping advance knowledge in a particular field, supporting the progression of a professional career, satisfying the donor who provided the

funding for research, and of course, becoming famous. The most important reason to write research papers and reports is to communicate—because effective communication is vital for science to progress.

The first questions

Before starting to write a scientific paper or report, ask yourself the following questions:

- Has the research work advanced enough to be reported?
- Is this to be a progress report, a final report of the research or a paper for publication?
- Is the paper or report to be submitted to a donor, to an institution of higher learning for a degree or as an organizational annual report?
- Have you made a plan as to how to write the paper or report?

Characteristics of a good scientific paper

A good scientific paper should—

- present an accurate account of the research investigation
- be clearly written and easily understood
- follow the particular style of the scientific discipline
- be free of jargon and local slang
- have appropriate and adequate illustrative material, all of which should be relevant to the subject of the report
- not contain any plagiarized material (plagiarism is a serious offence and is a serious charge against an author; see unit 15)

Structure of a research paper

In general, a research report or paper is written using the IMRAD logic. This very simple format is universally used in scientific reporting. The acronym IMRAD is derived from—

Introuction

Materials and methods

Results

And

Discussion

The parts of a paper—in brief

A typical scientific research paper consists of the following elements, listed here in the order in which they appear in the paper.

Title: As this is the 'label' of the paper, make it brief and suitable for indexing

Authors: List the names of the people who have done the work and written the paper

Postal addresses: Include full addresses, to enable readers to correspond with the authors

Abstract: Briefly describe the problem and the solution

Introduction: *What is the problem? Define your parameters*

Materials and methods: How did you study the problem? Enable others to repeat your experiment

Results: What did you find? Present data

Discussion: What do these findings mean? Discuss your results

Acknowledgements: Give credit or thanks to those who helped substantially

References: List your authority for statements made

Guidelines for the parts of a paper

These guidelines have been taken from *Editing and publication: a training manual*¹; see the recommended reading list at the end of this manual. Although the elements of a typical research paper follow one another as listed above, we will deal with them here following the IMRAD form—often the order in which the parts are written.

INTRODUCTION

A good introduction is relatively short. In general it—

- tells why the reader should find the paper of interest
- tells why the author carried out the research
- gives the background the reader needs to understand and judge the paper

1 with permission from the author, Ian Montagnes, and the publisher, the International Rice Research Institute (IRRI)

Specifically it—

- defines the nature and extent of the problems studied
- relates the research to previous work—perhaps by a brief review of the literature, but only that which is clearly relevant to the problem
- explains the objectives and method of investigation, including, if necessary, the reason why a particular method was chosen
- defines any specialized terms or abbreviations to be used in what follows

Watch that—

- you lead logically to the hypothesis or principal theme
- you state the hypothesis clearly
- your introduction does all that it should in no more than two typewritten pages

MATERIALS AND METHODS

The simplest way to organize this section is chronologically. You must provide all the information needed to allow another researcher to judge your study or actually repeat your experiment. The section includes—

- the design of the experiment
- any plants or animals involved, with exact descriptions (genus, species, strain, cultivar, line, etc.)
- The materials used, with exact technical specifications and quantities and their source or method of preparation. (Generic or chemical names are better than trade names, which may not be universally recognized)
- the assumptions made
- the methods followed, usually in chronological order, described with as much precision and detail as necessary. (Standard methods need only be mentioned, or may be described by reference to the literature as long as it is readily available. Modifications of standard techniques should be described. If the method is new it should be described in detail. Methods of interpreting data should be described as well as methods of finding data)

Watch that—

- there are no ambiguities in abbreviations or names
- all quantities are in standard units
- all chemicals are so specifically identified that another scientist can match them exactly in repeating the work
- every step is stated, including the number of replications
- all techniques are described, at least by name if they are standard or in as much detail as needed if you have modified a standard technique or devised a new one
- nothing is included that does not relate to the results that follow
- there are no unnecessary details that may confuse the reader

RESULTS

This is the core of the paper, presenting the data that you have found. It is usually easiest to follow the results if you present them in the same order as you gave the objectives in the introduction. Well presented results—

- are simply and clearly stated
- report representative data rather than endlessly repetitive data
- reduce large masses of data to means, along with the standard error or standard deviation
- report repetitive data in tables and graphs, not in the text
- repeat in the text only the most important findings shown in tables and graphs
- include negative data—what was *not* found—if (but only if) they affect the interpretation of results
- give only data that relate to the subject of the paper as defined in the introduction
- refer in the text to every table and figure by number
- include only tables, figures and graphs that are necessary, clear and worth reproducing

Watch out for and avoid

- repetition of data
- unnecessary negative data
- unnecessary figures or graphs
- unnecessary words

DISCUSSION

Here you explain what the results mean and their implications for future study. This is the most difficult part of the paper, in which you pull everything together and show the significance of your work. Your reader should not end up saying, 'So what?' A good discussion—

- does not repeat what has already been said in the review of literature
- relates the results to the questions that were set out in the introduction
- shows how the results and interpretations agree, or do not agree, with previously published work
- discusses theoretical implications of the work
- states conclusions, with evidence for each
- indicates the significance of the results
- suggests future research that is planned or is needed to follow up the results

Be sure that you have—

- dealt with each of the originally stated objectives
- followed the order of your original objectives
- introduced previously (most likely in the introduction) the subject of each conclusion, so that none comes as a surprise
- avoided unnecessary detail or repetition from preceding sections
- reported previously all methods, observations or results referred to in this section—none of these should be mentioned for the first time
- interpreted the results and suggested their implications or significance

TITLE

The title of your paper will probably be read more than any other part, both by scientists scanning the contents of a journal and by those depending on searches through secondary sources, which always carry the title and author but may or may not carry abstracts. The title may be reprinted in bibliographies and subject indexes, stored in bibliographic databases and cited in other articles. A good title may help future researchers find important information, a poor title hamper them from doing so. A good title for a research report—

- contains as few words as possible (many journals limit titles to 25 words; some want fewer)
- describes the contents of the paper accurately
- describes the subject as specifically as possible within the limits of space
- avoids abbreviations, formulas and jargon
- usually omits the verb and is only a label
- is as easy to understand as possible
- contains key words, for the benefit of information retrieval systems

Be sure that you—

- cut out unnecessary words, especially like 'Some notes on . . .' or 'Observations on. . .'; make your title come to the point
- write a title that is accurate and specific
- do not promise more than is in your paper; usually a title reports the subject of the research rather than the results
- include as many key words as possible, as they will be used for indexing and computer searching
- make the most important words stand out, usually by putting them first
- follow the style preference of the publication for which you are writing

AUTHORS

The names should—

- be complete enough to ensure proper identification; if there is any chance of confusion, use full names instead of initials
- include only people who are truly authors
- be listed in a logical order—for instance, alphabetically or in order of importance to the work being reported
- each be followed by an address, presented according to the style of the publication for which the paper is being written

Remember that—

- only people who have made an important contribution to planning and carrying out the research should be listed as authors
- anyone listed as an author should also have helped to draft the paper or have revised important parts of it

- as collecting data is not enough to make a person an author, technicians and other helpers are usually mentioned in the acknowledgements
- each co-author should give final approval to the version that is to be published
- unless names appear alphabetically, the first person listed is considered the senior author; others may be listed according to the importance of contribution to the experiment. Sometimes the head of a laboratory or institute wants to be considered an author of all papers coming from the organization; a proper place is as the last author, recognized as a position of importance
- the battle to get listed as an author may become severe; it is wise to agree on authorship and order even before the study begins, although they may be changed later

ABSTRACT

The abstract should be *definitive* rather than *descriptive*; that is, it should give facts rather than say the paper is 'about' something. A good abstract

- is short—usually 200 to 250 words, usually in one paragraph
- stands on its own, is complete in itself (it may be published separately in secondary sources)
- reports the objective of the research, its extent or scope, the methods used, the main results including any newly observed facts, the principal conclusions and their significance
- contains all the key words by which the paper should be indexed. These are sometimes listed separately below the abstract

It should *not* contain—

- references to tables or figures, as these appear only in the paper
- abbreviations or acronyms unless they are standard or explained
- references to literature cited
- any information or conclusion not in the paper itself
- general statements or abstracts; findings should be given as hard facts

ACKNOWLEDGEMENTS

Here you can thank any institution or individual who helped significantly in your work. This may be a granting agency that

supplied funds, a laboratory that supplied materials, or a person who gave advice. You can say here if your work arose from your thesis.

If there is no separate acknowledgements section you may include such material in the introduction or as a footnote or endnote.

REFERENCES

The reference list must include all works cited in the text and no works not cited. See unit 7 for detailed information on preparing your reference list.

TABLES AND FIGURES

See units 8 and 9 for information and guidelines on how to prepare your tables and figures.

4

Writing a research paper

Purpose

This unit will help training participants to:

- construct a skeleton or a plan for a research paper
- produce a preliminary draft of a scientific paper
- produce a final version of a paper that is suitable in form and content for the chosen journal

TO WRITE WELL it is first necessary to plan—effective writing is systematic. Words must be arranged in a logical order and should be carefully chosen to say what the writer means, clearly and concisely. Unless you are an experienced writer, don't try to write a research paper from start to finish. The basic technique of research is a planned approach to a clearly defined problem. This is the same way to approach writing a paper. The structure of the paper will come from the subject itself, the purpose of the paper, and the intended audience.

First, you must decide that you have enough—that you have a message to deliver. Otherwise, you are likely to quit halfway through, believing that writing papers is too difficult. Once you are sure of what you want to say, you can apply some of the simple

principles described here to help you start—and finish—writing a paper.

Many of the statements of scope in the research journals include the word 'significant'. Editors of journals are looking for 'significant results' or 'papers reporting a significant advance in knowledge'. That is one of the first questions that the editors of the journal will ask themselves when they receive your paper. Is the information in the paper significant, new, and worth publishing?

To help you decide this, look at your work objectively, as if someone else had written it. Put yourself in the place of an editor or a referee. They will be asking themselves the question, 'Why should I publish this paper?' You have to make sure that the answer is, 'Because it is a good piece of work' You must be sure of the worth of your work, because what you write will have to stand up to the examination of the editor and the criticism of referees.

Begin by writing a working title for the paper. You can usually start with the title of your original research proposal. Next write a summary of your results and what they show so far. You can then look at your working title and summary to decide if your results are worth publishing.

Once you are sure that you have the material to write a paper, you must think about your audience. Why are you writing the paper? You are writing it so that it will be read, and for that to happen, it must be published. Many authors do not consider this. They see the paper as an object in itself and do not think about who will be reading it. From the very start, you should aim at getting the paper seen by the right audience. To do this, you should direct your paper toward a specific journal that is read by the people you want to reach.

Making a plan for the article

Look at the way that the articles in the journal you have chosen are subdivided. This layout will give you a valuable clue about how to start planning your article. Most types of research article follow the classic IMRAD pattern, described in unit 3.

Building up the plan

You should write a paper systematically, building it as you go, step by step, rather than trying to do the whole thing at once. You must have a plan. The best way to develop a plan is to look back at the questions on page 12 in unit 3 relating to the structure of a research paper and think about the answers.

Look at each of the questions in turn and make notes about how you will answer them. This will help you develop an outline for the paper. The outline can be quite informal in its structure, as it is simply an aid for you. It will be a summary, in note form, of the entire article, a framework on which you can gradually build a complete paper.

First, decide on the main sections of the article. They will give you an overall plan that will help in your next task, which should be to plan separately what to include in each division. Look at a single heading, for example, Materials and methods. Think about what materials you actually used and jot down a list, using working headings such as 'chemicals', 'animals', 'equipment', 'soils'. You likely already have noted these in your laboratory bench notebook.

You can do this with each part of the article in turn. Systematically take each section and ask yourself what you want to say. Work through each of your subdivisions, writing notes on what to describe. Most of these sections will be easy to recognize. You will have done your experiments in separate parts and taken the results in certain ways or for specific purposes. These form natural sections, which you can consider individually.

Your approach will be easier once you are sure what should go into each section. Go through the whole paper like this, making lists of headings so that when you have finished the plan of the article is in front of you. Now you can stand back and think. What have you left out? Is there a title for every part of your work? Have you repeated something? Should a particular heading be moved to another section? Spend some time doing this, because it will make your work much easier in the end. Writing from a plan is always easier than making up your plan as you go along.

Using your plan

Now that you have your master plan, what should you do? Some people will start writing, because they feel confident that they know what they want to say. If you can do that, well and good. But if you still do not feel confident, you can continue your step-by-step approach even further before you start writing. You should not feel that you have to plan the whole paper in one sitting. You can split up the planning and writing to fit your time. Carry a notepad with you, or some cards, and whenever a thought comes to you, quickly write it down. This process is especially useful for the Discussion section, which always requires a lot of thought and interpretation. Very often an important idea or a few fine sentences suddenly appear, apparently from nowhere, and you should record these thoughts as soon as they come or you will forget them.

As you make your notes, collect them in boxes or files, each separately labelled. When you make a note, store it away with your other notes for that particular section, and cross out that part of your master plan. One morning when you look at your plan, suddenly everything will be crossed out and your desk will be covered with files and notes. You have finished making notes. No more sections to consider. In fact, what you have done is virtually finish writing the paper. All the hard work, the thinking, is over. All you need to do now is take each list of notes and write it out in proper sentences. From now on the paper will write itself, but editing and revising afterwards will take some time.

Remember the references

As you plan the sections and make your notes, also remember to make notes about the references you will want to mention in the text, so that at the end of the planning you will have an outline of your reference list as well. As you select references, list them on cards, a card for each, or on computer, making sure to copy all the details you need to make each reference complete. Get the complete information on a reference you think you might use while you are doing your reading and library searching. You may find it difficult to retrieve some of the information if you try to do it later when the reference is no longer at hand.

Review the raw material

Now is a good time to look back at what you have done. Examine all your evidence again. Is it all relevant and vital to the paper? Do you still want to publish this paper?

Do you really need all those tables? Could you boil down your data and combine or simplify tables? Could some tables be expressed more simply as figures or graphs? Would a line drawing be better than the fuzzy little photograph you have? Consider these points now because the editor and referee will certainly do so later.

Have you left anything out? Are you going into too much detail—or not enough? Try to ask yourself the most difficult questions now so that you can change the structure of the paper before you are too involved in writing.

Making a start

Sometimes it is difficult to start. One way around this is to begin with the easiest section, Materials and methods, which is a simple description of what you used and what you did. Then you could go on to the Results, again because you only have to describe exactly what happened. By then you should be involved with the paper and ready to start on the difficult task of interpreting the results in the Discussion.

Another way is to try to write the most difficult section first, the Discussion, which contains much interpretation and independent thought. Everything after that is easier.

Consider your working day and when you can work on your paper. Most people do not have long periods of time to sit down and write. They must do an hour here, and a few hours there. Some people work at home with family life going on around them. When you work, you are being interrupted all the time, so your thoughts are being disturbed. You need to develop a working method that will suit the way you write in the time you have available.

Your approach should be to work on your writing whenever you have time. At this early stage you should imagine each section of the paper to be a separate part of the complete paper. When you have the time, take out your master plan and pick out one of the

headings. Take this single heading and start thinking about what you want to say about it. Start making quick notes, pieces of sentences, a plan of a paragraph. You may find that you need to subdivide the section even further. Go ahead and do it. Then, when it is time for a break, you can put away your notes and start again whenever it is convenient. Doing this means that you do not have to remember the whole plan of the article every time you want to start working. You deal only with individual sections, one at a time.

Writing the first draft

Once you have organized all your material, prepared the figures and made up the tables, written all your notes and assembled them in the order you want, you are ready to start writing. Once you start a section, you should write as fast as you can. Do not worry about language, grammar, style or spelling. Try to write simply. Just write down as much as possible while the flow of whatever section you are working on is clear in your mind. In this way you will have copy to work on later. It is always easier to come back to something than to start filling in a blank piece of paper. This first draft can be as untidy as you like. Only you will see it. Concentrate on scientific content and nothing else.

As you are writing, use any abbreviations that are useful, especially code words or names for longer terms. However, the use of abbreviations is strictly regulated in most journals, as is accepted nomenclature and terminology. When you are preparing later drafts of your paper, take care to use international units and nomenclature, and abbreviations and forms of words, species names, etc., that are acceptable to the particular journal.

Most important at this stage is to turn your notes into sentences and paragraphs. Finish with each section before going on to the next one. Do not go back and start revising parts of what you have written until you have completed your writing.

Be practical as well. Don't be afraid to use paper. Leave wide margins and plenty of space between the lines. You are certain to revise what you are writing and you will need physical space on the page to include all the words. If you are writing by hand, it may be best to use lined paper to keep your handwriting under control. Old computer printout is excellent for this. If you are keying in the

manuscript, then double space your printout so that you will have plenty of room to make corrections between the lines.

Revising the first draft

Once your first draft is finished, you can start revising the paper. Remember that there are many steps in the publishing process, and the manuscript usually needs changes at every one of them. You should never think that what you have just written is perfect. You should always be prepared to revise what you have written.

Remember also that at this stage the scientific content of the paper is your main concern. Do not waste energy worrying too much about grammar and style yet. As you are reading what you have written in the paper, ask yourself questions like this:

- Are all the parts of the paper properly described?
- Are there any major changes needed?
- Is the logic of the paper sound?
- Is the order of presentation satisfactory?
- Is all the text needed?
- Can any figures or tables be eliminated or combined?
- Is each piece of text in the correct section?
- Is the sequence of paragraphs correct?
- Are there enough or too many headings and subheadings?

Aims in drafting and revising

There are several things you should do to the drafts of the paper that you write:

- Review the scientific content of the paper until you are certain it is correct.
- Put the paper aside for several days or weeks and then reread it.
- Give a draft of the paper to someone else to review.
- Check the paper for language and style.
- Prepare the manuscript so that it can be submitted to the journal.

These steps should make the paper understandable on all levels. They can be dealt with in order as you make second and third drafts. But you can change the order as long as you consider all the above points at some time in the process.

The second draft

Once you have finished revising the first draft of your paper, it is time to tackle the second draft. Even professional writers usually prepare several drafts of any written document before it is polished enough to suit them. Don't worry if, even at this stage, the paper reads awkwardly. Time, patience and persistence are required ingredients for good writing.

From the practical point of view, there is only a certain amount of revision you can physically fit onto a page of your manuscript. Once a page is full of changes, you should retype it or key in your corrections so that you can see where you are, then carry on editing and revising.

Your main concern should still be the scientific content of the article. Do not start worrying about such minor things as correct spelling if you still have to make major changes to the text.

Once you are satisfied with the standard of your work and think you have a second draft, prepare the paper in a neat format, preferably the format of the journal. The next thing to do is to give the article to other workers in the same field and ask them to comment on the scientific content, pointing out errors of logic and interpretation, noting where your writing is clumsy, and recommending further improvements.

Also, and this is an important note, you should put the article away for a few days or a week, then come back and reread it. You will be surprised at how many changes will be obvious if you do this. A short time away from the work gives you a perspective that will allow you to judge what you have written. This is particularly important for judging whether you have given the right amount of emphasis to the various points of your paper. This is the time to use the organization of your paper and your choice of words to highlight the most important points you want to make.

Include all your changes and those of your informal reviewers to produce a new draft of the paper. Again, it may be best to make a fresh copy of the paper so that it is neat. You can call that the third draft.

The third draft

By now you should be confident of the scientific content and structure of the article. Now you have to make sure that the paper can be read easily and your message understood. This is important, because no matter how good your results are, if the reader cannot understand what you are trying to say, you are wasting your time writing the article.

Every section of the paper should be completely clear to the reader. This is one of the things that editors will be looking for. You should look for it as well.

Check the references

At this stage you must check that all the references in your reference list are mentioned in the text. Then look at it the other way around and check that all the references cited in the text are included in the reference list. Why? Because you have been adding and deleting sections of the paper and you might have added or deleted references without changing the reference list.

One careful way of checking the references is to lay the list out in front of you then work through the paper, stopping each time a reference is cited in the text. Does the reference correspond to the reference in the list? You might have changed things around at some stage so that the two no longer agree.

There are several main systems of citing and listing references, each with many stylistic variations. Read unit 7 on references for details. You should use the style of the journal for which you are writing. Work through and check every page of your manuscript and every reference. When you have finished, check that you have ticked every reference in the list. If some are not marked then you have to go back and look again to see where they should be cited in the text, or delete them. Then, when you have done all that, go back and check with the original reference, wherever possible, to make sure that all the information in the reference is correct.

Handling the figures and tables

If your paper is accepted, it will be set in type, so you must gather the figures and tables, and their titles and captions at the end of the

paper after the reference list. They should not be included where they are mentioned. This is because the tables and figure captions are usually set in a smaller size or different type than the main text, so typesetters like to be able to separate the two when they are working on the paper.

Are all the figures and tables present, and are they numbered correctly? You may have deleted or rearranged the figures and tables as you were writing the paper. Check that all the tables and figures with the paper are mentioned in the text, and that all the tables and figures mentioned in the text are included with the paper. Check also that the figure number on the original figure corresponds with its legend and its citation in the text.

The final manuscript

Remember that the paper you send to the journal must be prepared according to the rules of publishing and the instructions of the journal, in the right format, using proper units, nomenclature, etc. You might not think this is very important, but the journal editor will. You have to worry about only your own article. The editor has to worry about the whole journal. The editor wants all units, abbreviations, etc., to be the same in every paper in the journal. That is, the editor is looking for consistency throughout the journal. You should make sure that you prepare your final paper just as the editor wants to see it. Look again at the 'Instructions to authors.' Some of these are detailed. Note how wide the margins of the page must be, the line spacing, if headings should be on the left or in the middle of the page, how to indicate boldface and italic letters, and so on, and make sure that you and the person preparing the final text of the paper follow the guidelines.

Number all the pages. This is most important in case pages get out of order.

On the title page, make sure that you have given a title, the correct spelling of the authors' names, an accurate list of addresses for the authors, an abstract or summary, and keywords if required. In a multi-authored paper, you should make clear on the manuscript to whom the proofs of the paper should be sent—who is responsible for the paper and is the contact for the editor or publisher. If you do not say otherwise, the publisher will assume it is the first author on

the title page. Some journals ask for a covering letter that gives a lot of this information.

Check that you are sending the required number of copies. Check if you should enclose a computer diskette as well, containing the file of your paper. Check on the requirements for the figures—original drawings, photographs, and so on—and make sure you are following those instructions.

Wrap the whole package well, then look in the journal and find the correct address. You will often have to send the paper to an editor or editorial board at an address that is different from the publisher's address, so make sure you choose the right one. Some journals have different editors dealing with different parts of the world or with different subject areas. All this information is usually on the inside front cover of the journal; make sure you read it all carefully. Send the manuscript by airmail and wait for an acknowledgement. Registered mail is recommended.

If you do not receive a letter from the publishers within 6 weeks or 2 months, you should write, asking them to confirm that they received the package.

Make sure that you have a good quality copy of the same version of the article you sent off. If the script is stored on a computer, make sure you have a backup copy on a diskette, because if the paper is lost you will have to send new, good quality copies to the publisher again.

5

Scientific style and English in a research paper

Purpose

This unit will help training participants to:

- ❑ become aware of good writing style and how it can increase comprehension
- ❑ differentiate between the elements of good and poor style in research writing
- ❑ correct the style and English of a paper to increase readability

PUBLISHING IS A HIGHLY COMPETITIVE FIELD, and journals receive many more good papers than they can publish. An editor will select a well-written and well-presented paper before one that is clumsily written and presented, if the scientific quality is similar. Language and style are like packaging. Good packaging can never make up for poor content, but attractive packaging enhances good content. Clear, concise writing gives the impression of confidence and knowledge, credibility and authority.

Much of the advice on writing scientific papers applies to writing in general. The following points can help you in scientific writing. Even

so, bear in mind that few papers are rejected solely because of poor English. If the scientific content is good enough, the language can be corrected.

If English is not your first language, don't expect to write it perfectly. English is a difficult language to write well—even native English speakers have problems. Do not worry or waste time on the finer points of grammar. The journal editor or publisher will usually correct your language. The most important thing is that your message is clear. For editors to correct your language, they must be able to understand what you are trying to say. Be as definite and specific as possible when you are writing. Avoid vague statements. Be sure of what you want to say. Points follow for you to consider when you are writing and revising your paper.

- | | |
|----------------------------------|----------------------|
| □ simple and direct language | □ jargon |
| □ abstract nouns made from verbs | □ sentence structure |
| □ noun clusters | □ tense and voice |
| □ errors of meaning and form | □ personal pronouns |

Simple and direct language

Always choose the simplest way of saying something. Choose a simple word rather than a difficult one, a concrete word in preference to an abstract one, a familiar word instead of a rare one. Complex, hard-to-understand sentences are rarely good sentences. Good scientific writing communicates in simple terms, even though the subject may be complicated. Repeated use of unnecessarily difficult, abstract words and phrases makes the subject hard to understand.

UNNECESSARY AND DIFFICULT WORDS

'Verbosity' means to say a thing in a complicated way, with lots of words, usually to make it sound more important. This is poor style. For example, you might say: 'The efficacy of the soil restorative agent utilized was undeniable.' This is verbose. Much better if you write exactly what you mean in a direct and simple way

The fertilizer we used was effective.

Use simple verbs like 'use' instead of 'utilize'. Cut out phrases like 'It is interesting to note that . . .'. Many writing guides and grammar texts give lists of unnecessarily wordy ways of saying things and preferred, shorter alternatives. Always try to use the simple expression. Avoid 'buzz words' and phrases that are suddenly popular but are not well defined, for example, 'sustainability', 'participatory approach', 'proactive', 'gender sensitive'. Concentrate on what you want to say and try to say it in the simplest, most direct way.

DOUBLE NEGATIVES

In English you can use two negatives or negative words to make a positive statement. For example: 'It is not unlikely: 'not' is a negative, and so is 'unlikely', so they cancel each other out and mean: 'It is likely'. Although this sort of construction is common, it is convoluted and often gets in the way of plain speech. There is sometimes a fine difference in meaning between a positive statement and a double-negative one, but if your first language is not English, it is better to avoid using the construction. Examples are—

The total was not unimpressive. [It was impressive.]

Here the reader might miss the word 'not' and misunderstand the meaning.

At no time was the disease absent. [It was always present.]

This is verbose; it uses extra words to say a simple thing in a more complicated, less direct way.

No decrease in numbers of species. . .

This is vague and ambiguous. Does it mean 'numbers stayed the same. . . ' or 'numbers increased. . . '?

SPELLING

Check to see if the journal you have selected uses British or American spelling—or Canadian, which is a mix of both. Then use that style of spelling consistently. Consistency is part of the 'packaging' and helps give a paper a finished look.

Nouns from verbs

Abstract nouns are often those made from verbs. This can be done quite easily: 'to measure' gives 'measurement', a common English word. But because it is a noun you have to put a verb with it, for example, 'The measurement was done [or carried out].' Often it is much easier to use a verb and say that something was measured. So instead of: 'Measurements were carried out on the variation', write: 'The variation was measured.'

Or, if the subject is important: 'Yilma (1992) measured the variation.' Other common examples of this are 'production' from 'produce', 'interpretation' from 'interpret', or 'observation' from 'observe'. Using such abstract nouns too often produces long sentences and dull prose. The extra length comes in part from the length of the '-tion' nouns and in part from the need to use extra words as verbs. The dullness results from the abstractness of these nouns and the usually passive, weak verbs that must go with them. Replacing an abstract noun with a verb gives you more chance to bring the subject into the sentence and make it more alive and specific.

In science writing today, abstract nouns are extremely common, but it is better to avoid using too many of them. When you review your manuscript, look for the nouns ending in -tion, -ance, -sion, -ment, -ness, -cy. Usually you can replace them by rewriting the sentence using the verb. These changes may also shorten a sentence and put its elements into a clearer sequence. For example, not: 'It is possible that the pattern of herbs now found at the site is a reflection of past disturbances.'

Better, and fewer words:

The pattern of the herbs now found at the site may reflect past disturbances.

Noun clusters

In English, nouns can be used as adjectives and strings of them can be put together to form a phrase. To some, these clusters sound impressive. But in fact they hide the meaning of what you are trying to say and also make the message unclear or ambiguous, leaving your meaning open to interpretation. Although these noun clusters are used frequently, your writing will be clearer if you avoid them.

Note that nouns in a cluster are usually abstract nouns. Sometimes you can go back to the verbs and make a good sentence, with a clear meaning. Look at the way a noun cluster can build up. We can start with:

Research

which leads to:

Research dissemination

then:

Research results dissemination

then:

Research results dissemination improvement

and finally:

Research results dissemination improvement methods

This final phrase has become hard to 'unstring' and understand. It is much clearer if you break it up:

Methods of improving the dissemination of the research results

Unfortunately, noun clusters are common today, especially in science writing. Two nouns together are easy enough to understand; when more are strung together the meaning can be lost. As you look through your text, mark the places where more than two nouns occur together. Then go back and try to rephrase the sentences, using verbs instead of nouns.

Errors of meaning and form

Make sure you understand the meaning of all the words you are using. Do not use a long word that you think sounds impressive unless you are certain of what it means. If you have used it wrongly, you will hide what you are really trying to say. Much better to use several simple words that give the correct meaning and are easily understood. There are also many words in English that look almost

the same but have different meanings, sometimes subtle—for example, 'various', 'varying', 'variable'.

Remember that words like 'data', 'phenomena' and 'criteria' are plural, not singular; 'equipment' and 'information' are always singular and never take an 's'.

Jargon

According to the Oxford dictionary, jargon is 'a mode of speech familiar only to a group or profession'. All scientific disciplines have their own special language of technical words, but be careful not to use them in your manuscript without defining them. English has become the universal language of science because so many people understand it. But if the reader cannot understand the specialized terms you are using, you are not communicating. Remember that researchers outside your own field or discipline may not understand the terms. Review your manuscript to make sure you have defined all the 'jargon' that you may have included. For example—

- not:* Suakoko 8 rice yields less than other lowland varieties.
but: Suakoko 8, a lowland variety of rice, yields less than other varieties.
- not:* Samples were 5-cm augered from depths of 2 and 3 metres.
but: Samples from depths of 2 and 3 metres were taken with an auger 5 cm in diameter.

Sentence structure

Avoid long sentences. How long is a long sentence? Any sentence that is more than two typewritten lines may be too long. However, remember that a mixture of short and long sentences adds variety and improves the rhythm of your writing. There are several different types of sentences that are too long. Below are two common examples.

TOO MUCH INFORMATION IN THE SENTENCE

If too much information is compressed in one sentence, it is difficult to understand the message. If a sentence seems too long, look for a place to split it into separate parts. Read this sentence straight through, then ask yourself if you understood it all:

Preparation of the derivatizing agent required the addition of 5 ml molecular sieve-dried benzene to 200 mg nitrobenzoyl chloride in a test tube which was vortex mixed then 5 ml dry pyridine was added and lightly mixed after which a 1.5-ml portion was added to the dried ethers, the tube capped and heated for 45 min.

Several things are wrong with the sentence, but the main problem is the lack of punctuation. Breaking up the long string of words makes the text more understandable:

The derivatizing agent was prepared by adding 5 ml of benzene, which had been dried in a molecular sieve, to 200 mg nitrobenzoyl chloride in a test tube. This was mixed by vortex, 5 ml dry pyridine was added and the whole lightly mixed. A 1.5-ml portion was added to the dried ethers, then the tube was capped and heated for 45 min.

It takes up only slightly more space, and it is much clearer.

HIDING THE SUBJECT UNDER CONDITIONS

Often you may have a list of conditions that describe the main topic of the sentence, but by including them all you bury the main statement. Sometimes you can make a series of sentences, but at other times it may be better to take the conditions out of the way. Either start a new sentence after you have said the most important thing, or make a list.

For example, here is a long sentence with a list of conditions hiding the main subject.

If the society is to provide farmers with a milk-collection service and help them market their milk, and also dry their pyrethrum and help market it, and provide a ploughing and harrowing service, and market farmers' wool, it is meeting its objectives.

This can be understood much easier if the subject and verb are first identified and brought to the beginning of the sentence. A short list can follow:

The society can meet its objectives if it provides member farmers with the following:

- a milk-collection and marketing service
- a drying and marketing service for pyrethrum
- ploughing and harrowing services
- a wool-marketing service

Verb forms

TENSE

Most of the time the past tense is used in scientific papers because whatever is described in the paper has already happened. The Introduction describes work that has already been done. The Methods section describes how the current work was done, and the Results section describes what happened. However, in the Discussion section the present tense might be used for something that exists or has already been demonstrated. For example—

There are [present—already known] only 4 different amino acids in DNA, but we found [past] that . . .

Where you are making predictions or describing current work, you might use the future tense:

These results mean that less fertilizer will be needed.

ACTIVE AND PASSIVE VOICES

Many books on English style and grammar checks in word-processing software recommend that you avoid the passive voice because it makes text boring and dull, adds words, reduces impact and may confuse. This is true, but the passive voice is often used in scientific style. In the sentence 'We measured the variation' (active), it is clear that the subject (we) did something (measured) to an object (the variation).

In the passive voice the object comes first and has something done to it by the subject: 'The variation was measured by us.' But in the passive voice you can also leave the subject out and say: 'The variation was measured: Most of the time the subject is you, the writer, and the subject is not important in what you have to say. Readers do not need to be told that 'you' measured the variation. However, you should try to use the active voice where it fits,

because it adds variety and interest to your writing. Examples of passive and active construction—

passive: In this paper, the second approach is considered.

active: This paper considers the second approach. *or*
In this paper, we consider the second approach.

passive: The screening procedure is illustrated in Figure 5.

active: Figure 5 shows the screening procedure.

Personal pronouns

If you did the work, or if you think something is right, then you should say it. Don't say, 'It is felt by us that . . . ' or 'One of us . . . ' Take responsibility for your ideas or work. Classical science writing encouraged the use of impersonal language at the expense of readability and clarity. The contemporary trend is to use personal pronouns sometimes, to make a more lively style and easier reading.

Lists

Lists are often a good way to present material clearly and concisely. However, all items in a list should be grammatically parallel in their construction. They are in the list on the preceding page. Sometimes, however, an author starts a list one way and then 'switches gears' changing to a different construction halfway through. It would be *wrong*, for example, to write—

The objectives of the society can be met if it provides member farmers with—

- a milk-collection and marketing service
- to dry their pyrethrum and market it
- ploughing and harrowing services for members
- marketing their wool for them

A good way to check if your series is parallel is to see if each item correctly completes the introductory part of the list. The rule of parallel construction applies even if the list is in straight text, without 'bullets' (• or □) or items on separate lines.

Qualification

'Hedging', or qualifying a statement, is done when you are not certain of the truth of what you are writing. You use conditional verbs and qualify what you want to say. It is good to say 'perhaps' when you are not sure of something, but it can be taken to extremes: You can still stop short of being too definite by using a single conditional:

not: Within the limits of experimental error, and taking into account the variation in the statistical treatment, it may be likely that the drug produced a favourable response in the sample of patients.

but: The drug appears to have produced a favourable response. . .

The latter says the same thing and is a lot more effective in delivering its message.

Unbiased language

Watch carefully to make sure that your paper does not include hidden biases in its language. To say 'the farmer and his wife', especially in Africa, is not only biased—it is likely inaccurate, as such a high percentage of African farmers are women.

The English language has many words with discriminatory overtones, such as 'spokesman', 'mankind'. These guidelines give advice on how to write in English without bias.

'MAN' AS A VERB

Do not use 'man' as a verb. 'Work', 'staff', 'serve', 'operate' and other alternatives can be used instead:

not: The emergency room must be manned at all times.

but: The emergency room must be staffed at all times.

'MAN' AS A PREFIX

Speakers and writers often use 'man'-prefixed compounds in contexts where 'man' represents males alone or both males and females.

Alternatives for 'man' are 'humanity' and 'human beings'. With a little thought sentences can be rewritten:

not: Will mankind murder Mother Earth or will he rescue her?

but: Will human beings murder the Earth or will they rescue it?

Various sex-neutral alternatives to 'manmade' are available, 'including 'handmade', 'hand-built', 'synthetic', 'manufactured' (in this case 'man-' comes from the Latin *manus*, hand), 'fabricated', 'machine-made' and 'constructed'.

'Manpower' is usually replaceable with 'personnel', 'staff', 'work force', 'available workers', or 'human resources'.

'MAN' AS A SUFFIX

not: A spokesman of the corporation will meet with the press at 4 p.m.

but: A representative of the corporation will meet with the press at 4 p.m.

not: Englishmen are said to prefer tea.

but: The English are said to prefer tea.

See the list at the end of this unit for additional recommended alternatives.

THE PRONOUN PROBLEM

It has been common in English to use the pronouns 'he', 'his' and 'him' to refer to any unspecified or hypothetical person. Using 'he or she' or 'his or her' is clumsy. It becomes especially awkward when repeated. A writer can often recast the material in the plural, for example—

not: Each farmer received his share.

but: All farmers received their share.

not: The learner should not be cut off from his roots; his own culture and traditions should be respected.

but: Learners should not be cut off from their roots; their own cultures and traditions should be respected.

One may also substitute the 'he' with 'they' without changing the verb. This may seem grammatically wrong, but, in fact, 'they' was

used as a singular pronoun long ago, as in Lord Chesterfield's remark (1759),

If a person is born of a gloomy temper. . . they cannot help it.

Pronouns may also be eliminated by repeating the noun they refer to, but again this can sound clumsy. A synonym or substitute for the word may also be used.

not: The farmer may have to do all the field work himself.

but: The farmer may have to do all the field work alone.

not: With this technology, the farmer makes best use of his farmyard manure and his green manure.

but: With this technology, the farmer uses farmyard manure and green manure to the best advantage.

Instructions or practical advice can avoid the problem by addressing the reader directly, for example—

The warehouse store is another way for you to curb your food bills.

'One', or the passive voice, sometimes serves as a third-person pronoun.

The warehouse store is another way for one to curb one's food bills.

or

The warehouse store is another way for one to curb food bills.

or

Food bills can be curbed by using the warehouse store.

Contracts and similar formal documents may be found with 'he/she', 'his/her', and so on, where one pronoun or the other must be selected. However, avoid using 'he/ she' in your writing.

ASSIGNING GENDER TO GENDER-NEUTRAL TERMS

The assignment of gender to common-gender nouns may distort the information being presented, such as when terms like 'immigrants', 'settlers' and 'farmers' are used in contexts that refer to males only. Many farmers in the developing world are women. According to United Nations estimates, women produce 60% to 80% of the food supply in Africa and Asia. Nevertheless, many people will be

surprised and even confused by a statement such as, 'The farmer showed she knew more than the scientist'.

GRATUITOUS MODIFIERS

Gratuitous modifiers often slip into writing as a result of prejudice or out of habit, such as 'women scientists', 'women students', 'a woman photographer'. In most cases such sex-specific modifiers can be deleted.

PERSONIFICATION

Many pronouns in English are traditionally (not grammatically) given a sex. Cars and ships are frequently called 'she'. Use 'it' instead. Do not write 'sister centre' or 'sister institute'; instead use 'related centre' or 'sibling centre', or change the sentence.

GIRLS, LADIES, FEMALES, WOMEN

These words have strong overtones of immaturity and dependence in the case of 'girl'; of decorum and conformity in the case of 'lady'. They can be very offensive, such as—

I'll have my girl make some copies right away.

The ladies may join us at the coffee break.

'Lady' is not a synonym for 'woman'. 'Lady' is used most effectively to evoke a certain standard of propriety, correct behaviour or elegance. However, 'ladies' may safely be used in 'ladies and gentlemen'.

Used as either a noun or an adjective, 'female' is appropriate when the corresponding choice for the other sex would be male:

The ewe had triplets last night: 2 females and 1 male.

'Woman' is the most useful all-round word for referring to an adult female person:

The project team of 7 women and 5 men was chosen quickly.

Traditionally, women tend to be seen as wives, whereas men are called 'men' more often than 'husbands', which is the appropriate

parallel term. 'Spouse' is a gender-neutral word. If the husband is referred to, then his spouse is his wife. If the wife is referred to, then her spouse is her husband.

'To father' (the biological act of insemination) is disappearing. A new word, 'parenting', is gaining acceptance.

Note also the following error:

not: Research scientists often neglect their wives and children.
[Thus the scientists must be men.]

but: Research scientists often neglect their families. [The scientists may be men or women.]

Used as a noun 'woman' connotes independence, competence and seriousness of purpose as well as sexual maturity.

DESCRIBING PEOPLE BY APPEARANCE

Emphasis on the physical characteristics of people, particularly women, is offensive in contexts where men are described in terms of achievements or character. It is still common to come across gratuitous references to a woman's appearance in contexts where similar references to a man would be ludicrous. Similarly, there is no need to refer to anyone's complexion or build in science or official writing.

TRIVIALIZING

Language used to describe women's actions often implies that women behave more irrationally and emotionally than men; for example, it would seem that women 'bicker' but men 'disagree'.

NAMES AND TITLES

Women are frequently referred to by their first names in circumstances where men are called by their last names, in particular in the titles of papers and books. There is no reason for this. However, some women prefer to use their first names to avoid possible confusion. This is a matter of personal preference. Unless specifically requested, use initials only. The impression created, intentionally or not, is that women merit less serious consideration, less respect:

not: Dr JD Morgan and Dr Judith James
but: Dr JD Morgan and Dr JE James

MRS, MISS AND MS

Because many people feel strongly about social titles, the obvious and courteous solution for anyone writing about or to a particular woman is to follow her preference. If this is not known, use 'Ms'.

CORRESPONDENCE

The salutation 'Dear Sir or Madam' is permissible but clumsy. 'To the addressee' or 'To whom it may concern' can be better. Some contemporary letter forms omit the formal salutation altogether.

ALTERNATIVE TERMS

<i>Sexist term</i>	<i>Recommended alternative</i>
Businessman	business manager, executive, head of firm, agent, representative, business traveller; (plural) business community, business people
Cameraman	photographer, camera operator, (plural) camera crew
Chairman	president or chair; use chairman or chairwoman when an established body is referred to and when a specific known person is meant (cf. spokesman); for all new bodies set up, use president or chair
domestics, maids, servants	domestic worker
Forefathers	ancestors, forebears
foremen	supervisor
Frenchmen, etc	the French
freshmen	first-year students
gentleman's agreement	unwritten agreement, agreement based on trust
girl Friday, man Friday	aide, key aide, assistant, helper
lady	use lady only as a parallel to gentleman. Lady has become debased and its use is often jocular (see text)
man, mankind	people, humanity, human beings, humankind, the human species, the human race, we, ourselves, men and women, <i>Homo sapiens</i> , one, the public, society

<i>Sexist term</i>	<i>Recommended alternative</i>
[to] man	operate, work, staff serve at (or on or in)
Man and Biosphere	while existing titles of programmes, documents and so forth cannot be changed, avoid man, he, etc., in all cases in new titles
[to] man a project	to staff a project, hire personnel, employ staff
man-hours	work-hours, labour time
man-made	handmade, hand-built, human-made, synthetic, manufactured, fabricated, machine-made, artificial, of human construction, of human origin, built-up, industrial, human-induced
manpower	staff, labour, work force, personnel, workers, human resources, human power, human energy
man-to-man	one-to-one, one-on-one, person-to-person
middleman	trader
mother tongue	first language
Mr and Mrs John Smith	Jane and John Smith, Mr and Mrs Smith, Mr and Ms Smith
spokesman	spokesperson, representative; use spokesman or spokeswoman when a specific person is intended; use the nongender-specific term when the reference is indeterminate. This applies to 'man' terms generally
workman	worker
workmanlike	efficient, skilful

6

Numbers, units, abbreviations and nomenclature

Purpose

This unit will help training participants to:

- use the units, abbreviations, nomenclature and terminology that are common in research papers

THERE ARE MANY STYLES for using numbers, units, abbreviations. The styles in science writing are different from those used in the humanities or in journalism. Even in science writing, different journals and institutions follow different rules. The rules given in this unit are in common use.

Numbers

Because a numeral is more quickly comprehended than a word, the trend in science writing is to use arabic numerals in preference to words. A common style uses words for numbers from 1 to 9 and numerals for numbers of 10 and above, for example, 'more than two' and 'over 500'. In a mixed series where some numbers are over 10

and some are under, the recommendation is to use figures: 4 cows, 8 sheep, 25 goats (here the series is animals).

However, the *CBE Scientific style and format: the CBE manual for authors, editors, and publishers* (bibliographic details on p 126) recommends using numerals 'when the number designates anything that can be counted or measured':

1 tree 3 fields 24 cows 2 examples the 1st time

In either style, always use a word rather than a figure to start a sentence:

Fifty per cent of the farmers surveyed . . .

Both styles recommend using numerals with all units of measure, even those below 10. Place the unit after the numeral, with a space in between:

2 ml 5 ml 10 kg 6 min 22 °C

In text, figures a thousand and over but below ten thousand should be written without any space, comma, or point: 1000, 7689. Five-digit numbers should be written with a space after the second figure: 29 567. British and American practice is to mark the decimal point with a full stop and groups of three digits with commas; but European practice is to mark the decimal with a comma and the groups of three digits with a full stop or a space. So 10,500 means ten point five to some people and ten thousand five hundred to others. To avoid possible confusion, SI recommends using a point for the decimal (10.5 = ten point five) and a space separating every three digits from the decimal (21 000 = 21 thousand; 42 000 000.5 ... 42 million point five).

In a table or column with a mixture of values, 4-digit figures should also be written with a space:

23 678

10 456

6 990

3 000

It is better to use a word instead of many 0s: 25 million, not 25 000 000. In figures below 1, units should be adjusted to avoid a number of 0s, for example, 45 mg, not 0.045 g. Another way is to use numbers with factors of 10 after them: 3 500 000 = 3.5×10^6 .

SI recommends using the negative exponential with units: 560 mg kg⁻¹, rather than 560 mg/kg. Using more than one slash mark should always be avoided, as it is imprecise: not 11 kg/ha/mo but 11 kg ha⁻¹ mo⁻¹.

In scientific work, inclusive numbers are usually written in full, to avoid any chance of ambiguity: 1994–1996; 1994 through 1996; 175–182; 10–13; 224–228. There are two ways to shorten, or elide, inclusive numbers: 224–28 or 224–8; any of these styles may be used in a journal—check with the 'Instructions to authors'.

Dates

It is almost always best to write dates using a word (in full or abbreviated) for the month: 12 November 1994 or 12 Nov 1994 or 12 Nov 94. The abbreviated forms are commonly used in tables. Using all numbers can cause confusion; the date 12/11/94 would be read as the 12th of November in much of the world, but in North America it would mean the 11th of December.

When writing out a date in text, no punctuation is needed if you write day-month-year: 'The trial began on 5 December 1990 and continued until 4 December 1993.' Nor is it necessary (or even desirable) to write '5th December', '4th December'. If you write month-day-year, you must use a comma both before and after the year: 'The trial began on December 5, 1990, and continued until December 4, 1993.' If you use just month and year, you do not need a comma between them: July 1989, not July, 1989.

Day-month-year is a logical, ascending order of the elements in a date. Also logical is the descending order that ISO (the International Organization for Standardization) recommends, in an all-numeric date method of expression:

19920602 or

1992-06-02 or

1992 06 02

The order can be continued by adding hour, minute, second, if that degree of precision is required: 1995 04 18 1330 26.

Units

Units should be expressed in metric or SI measures. If you are using traditional or local units, or a unit that may be well known in only one country, include an SI equivalent so that other workers can fully understand the quantity you are talking about. Tables 5.1 through 5.7 are a handy reference for handling SI units and equivalents.

Table 6.1. SI base units and symbols

Quantity	Name	Symbol
Base units		
length	metre (meter)	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd
Supplementary units		
plane angle	radian	rd
solid angle	steradian	sr

Abbreviations

Abbreviations, or shortened forms of words or terms, are common in science today. Many scientific, technical and industrial bodies have adopted standard forms of abbreviation. The object of using shortened forms is to save space and make reading easier. For example, it is much more difficult to read glycerolphosphorylglycerol than GPG. But first spell out the whole word or term and follow it with the abbreviation in parentheses: (GPG). After that you can use GPG and the reader will know what it is. However, abbreviations are not usually used in a title or an abstract.

First spelling out a term before you abbreviate it avoids a common danger: what is obvious to you and familiar in your specific field may be completely unknown to workers outside that area. What might be obvious to all workers in one field or one country may not be so easily understood by scientists in another country or discipline.

Table 6.2 Examples of SI-derived units, including some with special names

Quantity	SI unit		
	Name	Symbol	In terms of other units
Activity (of a radionuclide)	becquerel	Bq	0 s^{-1}
Acceleration			m/s^2
Capacitance	farad	F	C/V
Current density			A/m^2
Electrical charge, quantity of electricity	coulomb	C	s·A
Electric potential, electromotive force, potential difference	volt	V	W/A
Energy, work, quantity of heat	joule	J	N·m
Energy density			J/m^3
Force	newton	N	$(\text{m kg})/\text{s}^2$
Frequency	hertz	Hz	s^{-2}
Heat capacity, entropy			J/K
Illuminance	lux	lx	lm/m^2
Luminance			cd m^2
Luminous flux	lumen	lm	cd·sr
Magnetic flux	weber	Wb	V·s
Moment of force			N·m
Power, radiant flux	watt	W	J/s
Pressure, stress	pascal	Pa	N/m^2

It is often impossible for a reader to work out what an unrecognized abbreviation stands for. However, you do not need to spell out, even the first time, abbreviations common throughout science, such as SI units.

Especially for a longer work, such as a proceedings or a book, you may want to include a list of the abbreviations you use so that readers can look them up easily.

Different journals have different policies about abbreviations. Rules on the use of abbreviations and symbols are included in almost every 'Instructions to authors'.

Table 6.3. SI unit prefixes

Term	Multiple	Prefix	Symbol
10^{24}	1 000 000 000 000 000 000 000 000	yotta	Y
10^{21}	1 000 000 000 000 000 000 000	zetta	Z
10^{18}	1 000 000 000 000 000 000	exa	E
10^{15}	1 000 000 000 000 000	peta	P
10^{12}	1 000 000 000 000	tera	T
10^9	1 000 000 000	giga	G
10^6	1 000 000	mega	M
10^3	1000	kilo	k
10^2	100	hecto	h
10^1	10	deca ^a	da
	1 unit	—	—
10^{-1}	0.1	deci	d
10^{-2}	0.01	centi	c
10^{-3}	0.001	milli	m
10^{-6}	0.000 001	micro	μ
10^{-9}	0.000 000 001	nano	n
10^{-12}	0.000 000 000 001	pico	p
10^{-15}	0.000 000 000 000 001	femto	f
10^{-18}	0.000 000 000 000 000 001	atto	a
10^{-21}	0.000 000 000 000 000 000 001	zepto	z
10^{-24}	0.000 000 000 000 000 000 000 001	yocto	y

^a In the United States, the spelling 'deka' is often used.

COUNTRY AND CURRENCY CODES

ISO has designated a 2-letter code for every country in the world, and a 3rd letter for the currency of the country. This system avoids having to use currency symbols—often not on keyboards or hard to get at on extended character sets. Thus instead of \$, £, ¥, Pt, *f*, the system advocates USD (US dollar), GBP (pound sterling), JPY (yen), and so on. Table 6.8 gives the country and currency codes for Africa, Table 6.9 for European Union countries and others worldwide that are commonly used.

CONTRACTIONS

A contraction is an abbreviation in which letters are removed from the middle of the word so that the last letter is the same as the full word, for example, Dr = doctor; concn = concentration. In the British style of punctuation contractions usually do not have a full stop (period) at the end, whereas abbreviations will, for example, temp. =

Table 6.4. Non-SI units (names and abbreviations) and their status in relation to SI.

Other units used with SI	Units in temporary use with SI	Units deprecated ^a
day (d, = 24 h)	angstrom (Å, = 10 ⁻¹⁰ m)	atmosphere, standard (atm, = 101 325 Pa)
degree (°, = [π/180] rad)	are (a, = 100 m ²)	calorie (cal, = 4.18 J) ^b
hour (h, = 60 min)	bar (bar, = 10 ⁵ Pa)	carat, metric (= 2 × 10 ⁻⁴ kg)
litre (l, L or ℓ = 1 dm ³) ^c	barn = (b, = 10 ⁻²⁸ m ²)	fermi = (fm, = 10 ⁻¹⁵ m)
minute (min = 60 s)	curie (Ci, = 3.7 × 10 ¹⁰ Bq)	gamma (γ, = 10 ⁻⁹ T)
minute (′, = [π / 10 800] rad)	gal (Gal, = 10 ² m/s ²)	gamma (γ, = 10 ⁹ kg)
angular second (″, = [π / 648 000] rad)	hectare (ha, = 10 ⁴ m ²)	kilogram-force (kgf, = 9.8067 N)
tonne or metric ton ^d (t, + 10 ³ kg)	knot (kn, = 1 nautical mi/h)	lambda (λ, = 10 ⁻⁶ l)
	nautical mile (= 1852 m)	micron = (μ, = 10 ⁻⁶ m)
	rad (rad, = 10 ⁻² Gy) ^e	stere (st, = 1 m ³)
	rem (rem, 10 ² Sv) ^f	torr (= 133.322 Pa)
	roentgen (R, = 2.58 × 10 ⁻⁴ C/kg)	

^a CGS (centimetre, gram, second) units that are not recommended for use with SI units include the erg, dyne, poise, stokes, gauss, oersted, maxwell, stilb and phot.

^b The SI equivalent of the calorie varies beyond the 2nd decimal place depending on the definition of 'calorie' being used.

^c In the United States, the symbol L is generally used and the spelling 'liter' is preferred to 'litre'.

^d The official SI name is 'tonne'; 'metric ton' is used in the United States.

^e The unit is 'rad', not 'radian'. 'Gy' = 'gray', the unit of absorbed radiation dose.

^f 'Sv' = 'sievert', the unit of radiation dose equivalent

temperature. However, the American style of punctuation uses a period after both abbreviations and contractions. Be sure to check the journal for which you are writing to determine which style it uses.

ACRONYMS

Words made up out of initial letters or parts of a name are called acronyms, for example, UNESCO for the United Nations Educational, Scientific, and Cultural Organization, WARDA for West Africa Rice Development Association. An acronym can be made for any long term, but all should be defined the first time they are used.

Table 6.5. Selected non-SI units of weights and measures in use in the United States and the United Kingdom and their metric (SI) equivalents

Common	Metric equivalent	Common	Metric equivalent
acre	4047 m ²	ounce (oz)	
board foot	0.00236 m ³	apothecaries	31.10 g
bushel		avoirdupois	28.35 g
US	0.0352 m ³	troy	31.10 g
imperial	0.0364 m ³	US fluid	29.57 ml
calorie (cal) ^a	4.18 J	UK fluid	28.41 ml
carat, metric	0.200 g	peck, dry	
cord	3.625 m ³	US	8810 cm ³
drachm (UK)		UK	9092 cm ³
dry ^b	3.888 g	pint (pt)	
fluid	3.552 ml	US dry	550.6 cm ³
dram (US)		US liquid	0.4732 l
dry ^b	3.888 g	UK	568.3 cm ³
liquid	3.697 ml	pound	
fathom	1.829 m	apothecaries (lb)	373.2 g
foot (ft)	30.48 cm	avoirdupois (lb)	453.6 g
furlong	201.2 m	troy (lb)	373.2 g
gallon (gal)		quart (qt)	
US, liquid	3.785 l	US liquid	0.9464 l
UK	4.546 l	US dry	1101 cm ³
grain (gr) ^c	0.065 g	UK	1137 cm ³
inch ^d	2.54 cm	rod	5.029 m
knot (kn)	0.514 m/s	ton (ton)	
mile (mi)		long	1016 kg
statute	1.609 km	short	907.2 kg
nautical	1.852 km	yard	0.9144 m

^a The value of a calorie in SI units beyond the 2nd decimal place depends on the definition of 'calorie' being used.

^b Apothecaries drachm or dram. The avoirdupois dram in both the United States and the United Kingdom is equal to 1.772 g.

^c The grain is a unit in both the avoirdupois and the apothecaries systems of measure.

^d The unit 'inch' should be spelled out. If it is abbreviated, a period must be used to distinguish the abbreviation 'in.' from the preposition 'in'.

SYMBOLS

Symbols are similar to abbreviations or acronyms, but they are usually shorter, for example, $A_{260\text{nm}}$ for absorbency at 260 nm, P_i for inorganic phosphate, Ω for ohm, % for percentage. Many symbols are widely accepted and do not need definition, but you should be careful to define any new or uncommon symbol.

Table 6.6. Some preferred (P) and alternate (A) ISO units for general use

Quantity	Application	Unit	Symbol
Area	land area	square metre (P)	m ²
		hectare (A)	ha
	leaf area specific surface area of soil	square metre square metre per kilogram	m ² m ² kg ⁻¹
Density	soil bulk density	megagram per cubic metre	Mg m ⁻³
Electrical conductivity	salt tolerance	siemens per metre	S m ⁻¹
Elongation rate	plant	millimetre per second (P)	mm s ⁻¹
		millimetre per day (A)	mm day ⁻¹
Ethylene production	N ₂ -fixing activity	nanomole per plant second	nmol plant ⁻¹ s ⁻¹
Extractable ions	soil	milligram per kilogram	mg kg ⁻¹
Fertilizer rates	soil	grams per square metre (P)	g m ⁻²
		kilogram per hectare (A)	kg ha ⁻¹
Fibre strength	cotton fibres	kilonewton metre per kilogram	kN m kg ⁻¹
Flux density	heat flow	watts per square metre	W m ⁻²
		gas diffusion	mole per square metre second (P) gram per square metre second (A)
	water flow	kilogram per square metre second (P)	kg m ⁻² s ⁻¹
		cubic metre per square metre second (A)	m ³ m ⁻² s ⁻¹ <i>or</i> m s ⁻¹
Gas diffusivity	gas diffusion	square metre per second	m ² s ⁻¹
Grain test weight	grain	kilogram per cubic metre	kg m ⁻³
Hydraulic conductivity	water flow	kilogram second per cubic metre (P)	kg s m ⁻³
		cubic metre second per kilogram (A)	m ³ s kg ⁻¹
		metre per second (A)	m s ⁻¹
Ion transport	ion uptake	mole per kilogram (of dry plant tissue) second	mol kg ⁻¹ s ⁻¹
		mole of charge per kilogram (of dry plant tissue) second	mol (+) kg ⁻¹ s ⁻¹ <i>or</i> mol (-) kg ⁻¹ s ⁻¹
		square metre per kilogram	m ² kg ⁻¹
Leaf area ratio	plant		
Length	soil depth	metre	m
Magnetic flux density	electronic spin resonance (ESR)	tesla	T
Nutrient concentration	plant	millimole per kilogram (P)	mmol kg ⁻¹
		gram per kilogram (A)	g kg ⁻¹
Photosynthetic rate	CO ₂ amount of substance flux density (P)	micromole per square metre second (P)	μmol m ⁻² s ⁻¹
		CO ₂ mass flux per density (A)	milligram per square metre second
Plant growth rate		gram per square metre day	G m ⁻² day ⁻¹
Resistance	stomatal	second per metre	s m ⁻¹
Soil texture composition	soil	gram per kilogram (P)	g kg ⁻¹
Specific heat	heat storage	joule per kilogram kelvin	J kg ⁻¹ K ⁻¹
Thermal conductivity	heat flow	watt per metre kelvin	W m ⁻¹ K ⁻¹

Table 6.6. *continued*

Quantity	Application	Unit	Symbol
Transpiration rate	H ₂ O flux density	gram per square metre second (P)	$\text{g m}^{-2} \text{s}^{-1}$
		cubic metre per square metre second (A)	$\text{m}^{-3} \text{m}^{-2} \text{s}^{-1}$ or m s^{-1}
Volume	field or laboratory	cubic metre (P)	m^3
		litre (A)	l
Water content	plant	gram water per kilogram wet or dry tissue	g kg^{-1}
		soil	kilogram water per kilogram dry soil (P)
		cubic metre water per cubic metre soil (A)	$\text{m}^3 \text{m}^{-3}$
X-ray diffraction patterns	soil	radians (P)	θ
		degrees (A)	$^\circ$
Yield	grain or forage yield	gram per square metre (P)	g m^{-2}
		kilogram per hectare (A)	kg ha^{-2}
		megagram per hectare (A)	Mg ha^{-1}
		tonne per hectare (A)	t ha^{-1}
	mass of plant or plant part	gram (gram per plant or plant part)	$\text{g (g plant}^{-1} \text{ or g kernel}^{-1})$

Table 6.7. Factors for converting non-SI units to acceptable units.

Non-SI units		Acceptable units
Multiply	by	to obtain
acre	4.05×10^3	square metre, m^2
acre	0.405	hectare, ha (10^4 m^2)
acre	4.05×10^{-3}	square kilometre, km^2 (10^6 m^2)
Angstrom unit	0.1	nanometre nm (10^{-9} m)
atmosphere	0.101	megapascal, MPa (10^6 Pa)
bar	0.1	megapascal, MPa (10^6 Pa)
British thermal unit	1.05×10^3	joule, J
calorie	4.19	joule, J
calorie per square centimetre minute (irradiance)	698	watt per square metre, W m^{-2}
calorie per square centimetre (langley)	4.19×10^4	joules per square metre, J m^{-2}
cubic feet	0.028	cubic metre, m^3
cubic feet	28.3	litre, l (10^{-3} m^3)
cubic inch	1.64×10^{-5}	cubic metre, m^3
curie	3.7×10^{10}	becquereJ, Bq
degrees (angle)	1.75×10^{-2}	radian. rad
dyne	10^{-5}	newton, N
erg	10^{-7}	joule, J
foot	0.305	metre, m
foot-pound	1.36	joule, J
gallon	3.78	litre, l (10^{-3} m^3)
gallon per acre	9.35	litre per hectare, l ha^{-1}
gauss	10^{-4}	tesla, T

Table 6.7. continued

Non-SI units		Acceptable units
Multiply	by	to obtain
gram per square centimetre	1.00	megagram per cubic metre, Mg m ⁻³
gram per cubic decimetre	27.8	milligram per square metre second, mg m ⁻² s ⁻¹ (10 ⁻³ g m ⁻² s ⁻¹)
hour (transpiration)		
inch	25.4	millimetre, mm (10 ⁻³ m)
micromole (H ₂ O) per square centimetre second (transpiration)	180	Milligram (H ₂ O) per square metre
Micron	1.00	micrometer, m (10 ⁻⁶ m)
Mile	1.61	kilometre, km (10 ⁻³ m)
mile per hour	0.477	metre per second, m s ⁻¹
milligram per square decimetre hour (apparent photosynthesis)	0.0278	milligram per square metre second, mg m ⁻² s ⁻¹ (10 ⁻³ g m ⁻² s ⁻¹)
millimho per centimetre	0.1	siemen per metre, S m ⁻¹
Ounce	28.4	gram, g (10 ⁻³ kg)
ounce (fluid)	2.96 × 10 ⁻²	litre, l (10 ⁻³ m ³)
pint (liquid)	0.473	litre, l (10 ⁻³ m ³)
Pound	454	gram, g (10 ⁻³ kg)
pound per acre	1.12	kilogram per hectare, kg ha ⁻¹
pound per acre	1.12 × 10 ⁻³	megagram per hectare, Mg ha ⁻¹
pound per bushel	12.87	kilogram per cubic metre, kg m ⁻³
pound per cubic foot	16.02	kilogram per cubic metre, kg m ⁻³
pound per cubic inch	2.77 × 10 ⁴	kilogram per cubic metre, kg m ⁻³
pound per square foot	47.9	pascal, Pa
pound per square inch	6.90 × 10 ³	pascal, Pa
quart (liquid)	0.946	litre, l (10 ⁻³ m ³)
quintal (metric)	10 ²	kilogram, kg
Rad	1.00	0.01 Gy
Roentgen	1.00	2.58 × 10 ⁻⁴ C (coulomb) kg ⁻¹
square centimetre per gram	0.1	square metre per kilogram, m ² kg ⁻¹
square feet	9.29 × 10 ⁻²	square metre, m ²
square inch	645	square millimetre, mm ² (10 ⁻⁶ m ²)
square mile	2.59	square kilometre, km ²
square millimetre per gram	10 ⁻³	square metre per kilogram, m ² kg ⁻¹
temperature (°F– 32)	0.556	temperature, °C
temperature (°C + 273)	1	temperature, K
tonne (metric)	10 ³	kilogram, kg
ton (2000lb)	907	kilogram, kg
ton (2000lb) per acre	2.24	megagram per hectare, Mg ha ⁻¹

Nomenclature

The dictionary defines 'nomenclature' as a 'system of names for things; terminology of a science, etc.; systematic naming'. Different fields of science have different systems of nomenclature. There is

Table 6.8. ISO designations for African countries and their currencies

Country	Code	Currency	Code
Algeria	DZ	Algerian dinar	DZD
Angola	AO	kwanza	AOK
Benin	BJ	CFA franc BCEAO	XOF
Botswana	BW	pula	BWP
Burkina Faso	BF	CFA franc BCEAO	XOF
Burundi	BI	Burundi franc	BIF
Cameroon, United Republic of	CM	CFA franc BEAC	XAF
Central African Republic	CF	CFA franc BEAC	XAP
Chad	TD	CFA franc BEAC	XAF
Comoros	KM	Comoros franc	XAF
Congo	CG	CFA franc BEAC	XAF
Côte d'Ivoire	CI	CFA franc BCEAO	XOF
Djibouti	DJ	Djibouti franc	DJF
Egypt	EG	Egyptian pound	EGP
Equatorial Guinea	GQ	ekwete	GQE
Eritrea	EI	Eritrean birr	EIB
Ethiopia	ET	Ethiopian birr	ETB
Gabon	GA	CFA franc BEAC	XAF
Gambia	GM	dalasi	GMB
Ghana	GH	dedi	GHC
Guinea	GN	syli	GNS
Guinea-Bissau	GW	Guinea-Bissau peso	GWP
Kenya	KE	Kenya shilling	KES
Lesotho	LS	maloti	LSM
		rand	ZAR
Liberia	LR	Liberian dollar	LRD
Libyan Arab Jamahiriya	LR	Libyan dollar	LYD
Madagascar	MG	Malagasy franc	MGF
Malawi	MW	kwacha	MWK
Mali	ML	Mali franc	MLF
Mauritania	MR	ouguiya	MRO
Mauritius	MU	Mauritius rupee	MUR
Morocco	MA	Moroccan dirham	MAD
Mozambique	MZ	metical	MZM
Namibia	NA	rand	ZAR
Niger	NE	CFA franc BCEAO	XOF
Nigeria	NG	naira	NGN
Rwanda	RW	Rwanda franc	RWF
Senegal	SN	CFA franc BCEAO	XOF
Seychelles	SC	Seychelles rupee	SCR
Sierra Leone	SL	leone	SLL
Somalia	SO	Somali shilling	SOS
South Africa	ZA	rand	ZAR
Sudan	SD	Sudanese pound	SDP
Swaziland	SZ	lilangeni	SZL
Tanzania, United Republic of	TZ	Tanzania shilling	TZS
Togo	TG	CF franc BCEAO	XOF
Tunisia	TN	Tunisian dinar	TND
Uganda	UG	Uganda shilling	UGS
Western Sahara	EH	Spanish peseta	ESP
		ouguiya	MRO
		Moroccan dirham	MAD
Zaire	ZR	zaire	ZRZ
Zambia	ZM	kwacha	ZMK
Zimbabwe	ZW	Zimbabwe dollar	ZWD

Table 6.9. ISO designations for selected other countries and their currencies

Country	Code	Currency	Code
Australia	AU	Australian dollar	AUD
Belgium	BE	Belgian franc	BEF
Canada	CA	Canadian dollar	CAD
China	CN	yuan renminbi	CNY
Denmark	DK	Danish krone	DKK
European Monetary Cooperation Fund		European currency unit	ECU
Finland	FI	markka	FIM
France	FR	French franc	FRF
Germany, Federal Republic of	DE	Deutsche mark	DEM
Greece	GR	drachma	GRD
India	IN	Indian rupee	INR
Ireland	IE	Irish pound	IER
Italy	IT	lira	ITL
Japan	JP	yen	JPY
Luxembourg	LU	Luxembourg franc	LUF
Netherlands	NL	Netherlands guilder	NLG
Norway	NO	Norwegian krone	NOK
Portugal	PT	Portuguese escudo	PTE
Spain	ES	Spanish peseta	ESP
Sweden	SE	Swedish krona	SEK
United Kingdom	GB	pound sterling	GBP
United States of America	US	US dollar	USD

nomenclature for plants, animals, microorganisms; in chemistry and biochemistry; physics and mathematics.

The important point is that each system of nomenclature has strict rules that are well recognized, published and understood by a wide circle of scientists. Any new name created under these rules is understandable to anyone who knows the rules or knows where to look for them.

Often the 'Instructions to authors' of a journal will have detailed explanations of the nomenclature needs for papers submitted to that journal, and the editors of the journals will be glad to give you advice.

Scientific names

Taxonomy is a complicated subject, and the names of particular species need to be given clearly in any paper you are writing. You should take care to find and give the complete scientific name (the full binomial name in Latin) in the title, the abstract and the first time it appears in the text of a paper, in italic type (or underlined, if you do not have italics). Afterwards the generic name may be

abbreviated to a single letter, for example, *Escherichia coli* becomes *E. coli*. However, if two or more genera with the same initial letter are named, abbreviations such as *Staph.* and *Strep.* should be used to avoid confusion.

The genus name always begins with a capital letter; the species name always with a small letter. The same rule applies to subgenera and subspecies.

Rousettus (Rousettus) obliviosus—*R. (R.) obliviosus*

A genus name can be used alone, but a species name must always be preceded by the name (or the initial) of the genus. If the species is unknown or if you are referring to several species in a genus, you can use 'sp' (for one species) or 'spp' (for more than one species):

Acacia sp *Acacia* spp

The words or abbreviations that are not part of the Latin scientific name itself are not put in italics: sp., spp., var., cv., etc.

Celtis durandii Engl var. *ugandensis* Rendle

Often the authority—the person who first gave the taxonomic description of the organism—is included the first time the name is mentioned, the time it is given in full. The authority is not italicized:

Culex pipiens quinquefasciatus Say

The name of the authority is often abbreviated:

Acacia senegal (L.) Willd.

The rules for the plant sciences and those for the animal sciences differ slightly when a later taxonomist changes the placement of the organism, such as if it is moved to a different genus. In the animal sciences, the name of the original authority is then placed in parentheses:

Lepomis gulosus (Cuvier)

If we see this, we know that Cuvier originally described the animal but placed it in a different genus and that it was later moved into the genus *Lepomis*, where it is now. We do not know who made the move.

In the plant sciences, the names of both the original describer and the one who later made the taxonomic move are shown:

Haplopappus radiatus (Nutt.) Cronq.

Here Cronq. moved the plant from the genus *Pyrocoma*, where Nutt. originally placed it (original name: *Pyrocoma radiata* Nutt.), to the genus *Haplopappus*.

In another example, the original description was

Pinus murrayana Balf.

A later decision was that the tree was not a separate species but a variety; now the name is

Pinus contorta var. *murrayana* (Balf.) Engelm.

Scientific names of all categories above genus—family, order, phylum—start with a capital letter but are not italicized:

Compositae Diptera Arthropoda

Often a scientific name is the same as the common name:

Acacia acacia

Or it may be 'anglicized', that is, given an English ending:

Compositae composite

In these cases, the word is neither italicized nor capitalized.

Recommended forms and spellings

Abbreviations and symbols can have several forms; simple English words can as well. In fact, many words in English can have different forms, each one of them correct, for example, appendices, appendixes. Journal editors like to see consistency in the papers in their journals and will use one form of a particular word. These choices are part of the editorial style, as is the choice of British or American spelling. Carefully study papers in previous issues of the journal and look at the 'Instructions to authors' for guidance.

Mathematical symbols and equations

When writing equations in your paper, you should take extra care that they are clear to the editor and typesetter. A letter or symbol in the wrong place can change the meaning of an expression.

Consider the following points.

Consider writing your expressions in the simplest possible form so that they are easy to set in type. For example,

$$\frac{\mathbf{a + b}}{\mathbf{c}}$$

is more easily set as $(a+b)/c$, and means the same thing. However, equation editors in word-processing software now make complicated equations much easier to set up. If the equation is long and complicated, it should be 'displayed', that is, written on a separate line and not in the text.

All letters that substitute for a value should be set in italics (or underlined in the manuscript if you do not have italics available), except for vectors, which are printed in bold italic. If you do not have bold italics, indicate vectors by underlining them with a wavy line and a straight line. Make sure your subscripts (such as V_i), superscripts (such as I°) and spacings will be clear to the editor.

Use brackets in this order. parentheses () first, then square brackets [] outside these, then braces { } outside those, for example—

$$\{[x(a+b)] [y(c+d)]\}^2$$

Some have a special meaning, for example, $[\text{Na}^+]$ means concentration of sodium ion, and $[^{14}\text{C}]$ formate is formate labelled with radioactive carbon.

The first time you use a Greek letter write out its name in full in the margin. Do the same with mathematical symbols. If any of these are unclear in your typescript, write them out in full for the editor.

If you are unsure of how to express mathematics as equations, you should always get the advice of an expert or look at a guide.

Reference

CBE Style Manual Committee. 1994. *Scientific style and format: the CBE manual for authors, editors, and publishers*. 6th ed. Cambridge: Cambridge University Press.

References

Purpose

This unit will help training participants to:

- ❑ recognize the three common styles of references in the biological sciences
- ❑ cite a reference correctly in the text
- ❑ be aware of the elements of a publication that are included in a reference
- ❑ construct a reference list with the elements listed correctly

THERE ARE MANY different styles for listing references; every publisher, every journal seems to prefer its own variations. There is not a 'right way' and a 'wrong way' of listing references, but many ways, some with major, some with minute stylistic differences. Science editors are now trying to introduce some standardization.

When you are preparing a paper to be submitted to a journal or publisher, be sure to get the 'Instructions to authors' for that publication and follow its rules. Such a guide is generally published in the first issue of a new volume of a journal.

The three common styles for reference lists in the biological sciences are—

- ❑ name-year system

- numbered alphabetical list
- citation-sequence system, most frequently used in medical sciences

Name-year

In the name-year system, the author and year of publication are given in parentheses in the text; the list is arranged in alphabetical order.

EXAMPLE

Text citations: Ajayi (1987) or (Ajayi 1987); Franzel and others (1989) or (Franzel and others 1989)

Reference list

Ajayi O. 1987. The effect of different types of farmer participation on the management of on-farm trials. *Agric. Admin. Ext.* 25:235–52.
Franzel S, Legesse Dadi, Colburn F and Getahun Degu. 1989. *Grain marketing and peasant production in Ethiopia*. Research Report No. 5. Addis Abeba: Institute of Agricultural Research.

Numbered with alphabetical listing

The list in the numbered alphabetical system is arranged in the same order, but the references are numbered. The citation in the text is by number in parentheses rather than name and year.

EXAMPLES

Text citations: previous research has shown (2) or Franzel et al. (2); Ajayi (1) or previous reports have indicated (1). (Numbered in alphabetical order.)

Reference list

1. Ajayi O. 1987. The effect of different types of farmer participation on the management of on-farm trials. *Agric. Admin. Ext.* 25:235–52.
2. Franzel S, Legesse Dadi, Colburn F, and Getahun Degu. 1989. *Grain marketing and peasant production in Ethiopia*. Research Report No. 5. Addis Abeba: Institute of Agricultural Research.

Citation-sequence

In the citation-sequence system, each citation in the text is given a number, written as a superscript, in the order it is first mentioned; the reference list is arranged sequentially by number and is not alphabetical. Main name of all authors is given first, followed by initials; no periods, no commas.

EXAMPLES

Text citations: previous research has shown¹

or Franzel et al.¹; Ajayi²

or ...previous reports have indicated². [numbered in the order in which they first appear in the text]

Reference list

1. Franzel, Steven; Legesse Dadi; Colburn, Forrest; Getahun Degu. *Grain marketing and peasant production in Ethiopia*. Research Report No. 5. Addis Abeba: Institute of Agricultural Research; 1989. 48 p.
2. Ajayi O. The effect of different types of farmer participation on the management of on-farm trials. *Agric Admin Ext* 1987;25:235–52.

The explanations and examples here are on the name-year system. But in any of the systems, the same items of information, in the same order, except for the year, are given for each reference.

Within these systems there are many variations, some minute, such as whether to enclose the year in parentheses or not, whether to put full stops after authors' initials, whether to write journal titles in full or abbreviate them. The general objective of the citation style being recommended by science editors associations is to produce an easily understood citation with a minimum of punctuation marks.

The rules below, for the name-year system, are those followed by many international agricultural research centres. You should modify them according to the style of your organization or the style of the publication for which you are writing.

CITATIONS IN THE TEXT

Use no comma between the author and the year:

(Mungai 1990)

(Mungai and Taylor 1993)

(Mungai et al. 1991)

(Mungai and others 1991) [preferred by CBE over 'et al']

For example: Some trees are tall and some are short (Mungai 1990). Mungai and Taylor (1993), however, state that 'a tree is a bush that made it'. [Note the use here of single quotes and the period outside the quote—a British style of punctuation.]

If you are making several quotes from a work, then use the following to be specific as to location:

(Mungai 1990 p 33)

(Mungai 1990 p 33–44)

(Mungai 1990 ch 7)

Examples of other variants

(Mungai 1990, 1992; Taylor 1993)

(Mungai 1990a, 1990b)

(Mungai A 1990) [where Mungai B also wrote in 1990]

(Alexander B Mungai, personal communication) [does not appear in reference list]

(Amare Getahun 1988) [see 'alphabetical order', below]

THE REFERENCE SECTION

The reference section is where you give all the details a reader will need to find the work being cited. If the paper you are working on is to be submitted as a manuscript, double space the reference list, just as you do the text; do not add extra space between items. If you are submitting final copy in a report that is single spaced, single space your reference list as well. Use a hanging indent style.

Major components in the listing for a journal article, in order—

author

date

title of work cited
name of journal
volume, inclusive pages

Major components for a book

author
date
title of book
city of publication, publisher
inclusive pages cited (see 'page numbers' below)

Major components for a chapter in a book or a paper in a proceedings—

author
date
title of chapter or paper
inclusive page numbers
title of book or proceedings
city of publication: publisher

AUTHOR AND YEAR

Note the inverted order and the reduced punctuation in the layout of the author's names in the following examples:

Mungai A and Taylor B. 1990. [last name first for all authors, no commas]
Mungai A, Taylor B and Ampofo CD. 1993. [no comma before 'and']
Mungai A in press. [use sparingly, and only if really in press]
Mungai A ed. 1990.
Mungai A and Taylor B eds. 1991.

Give the names of all authors here; do not use 'and others' or 'et al.' in the reference list. You may use — [a 3-em dash] for successive references by the same author or authors if the author entry is exactly the same.

Names with particles are often a problem. Spelling and alphabetizing should follow the personal preference of the author. But determining

what that is may not be easy. Wide variation exists, as the following names illustrate:

Braun, Wernher von	Gogh, Vincent van
de Gaulle, Charles	Guardia, Ricardo Adolfo de
De la Ray, Jacobus Hercules	la
Deventer, Jacob Louis van	La Guardia, Fiorello H.
De Vere, Aubrey Thomas	Robbia, Luca della
DiMaggio, Joseph Paul	Van Devanter, Willis

Compound names, with or without hyphens, should also be alphabetized according to personal preference or established usage:

Atta-Krah, Kwesi	Norton-Griffiths, M.
Castelnuovo-Tedesco, Mario	Teilhard de Chardin, Pierre
Lloyd George, David	Vaughan Williams, Ralph

Many languages and cultures have their own systems of naming and alphabetizing: Arabic, Chinese, Ethiopian, Hungarian, Indonesian, Spanish, Vietnamese. Not all are listed here. The best approach is to determine how the names have been alphabetized and handled in previously published work. Examples of names that are not inverted but are alphabetized by the first word—

Amare Getahun	Ng Siew Kee
Bahir Jama	Tran Van Nao

ALPHABETICAL ORDER

In the name-year system, all lists of literature cited should be in alphabetical order by surname (or main name) of first author, then initials if there are two authors with same surname, then by date. All works by an author alone precede multiauthored works. Works written by an author precede those edited by the same author. Works published in the same year are alphabetized by title. Multiauthored works are alphabetized by surname of the first author, then of the second, and so on:

Mungai A, Brown B and Taylor C
precedes
 Mungai A and Robinson B

With the same name(s) and year, use ‘a’, ‘b’ after the year [example: Mungai 1990a, 1990b].

Alphabetize 'Mc' following the order of the letters, not as if it were written out 'Mac': MacBrayne, Mackenzie, McDonald. Alphabetize ‘St’ in the same way, not as if it were written out ‘Saint’: Simmons, Stanley, St Vincent.

TITLE

The title of an article in a journal or magazine or a chapter in a book is not italicized, nor is it enclosed in quotation marks. Capitalization is ‘sentence style’, that is, capitalize only the first word and proper nouns, as you would in a sentence.

The title of a book or the name of a journal may be italicized. The journal title may or may not be abbreviated according to journal or house style. There are definite rules for abbreviation of words in the title. If you do not know the proper abbreviation (which you usually can find in the journal itself in which you read the article), it is better to write out the whole title; then the editor can determine the correct abbreviation.

If text is to be italicized, use italics rather than underlining in your paper if possible. Eventually, whatever is underlined will become italics when the paper is printed. But words that are normally italicized, such as genus and species names, appear in roman if they occur in a title that is italicized.

Often extra information is included here, such as the edition of a book, the volume number if the book is one of a set of several volumes, the inclusive pages if the work cited is a chapter in a book. See the examples in the section following.

FACTS OF PUBLICATION

Give the publisher and the city where the book was published. One style is to give the city, followed by a colon, then the name of the publisher followed by a full stop. Another common style is to give the publisher, followed by a comma, then the city of publication. If there are two places of publication but only one publisher, give only the first place. If there are two publishers, it is permissible, but not necessary, to list both, as in the 4th example below. If the city is not

well known, give the country or state or province to help the reader identify it, such as to distinguish between Cambridge in England (well known, 5th example below) and Cambridge, Massachusetts, in the USA (less well known, last example):

New York: Wiley.

Washington, DC: World Bank.

Austin, Texas: University of Texas Press.

Chicago: University of Chicago Press; London: Routledge & Kegan Paul.

Cambridge: Cambridge University Press.

Cambridge, MA: Harvard University Press.

PAGE NUMBERS

For a journal article, give the volume, colon, inclusive pages. If you are citing pages from a book, give only the page numbers referring to the location of the information you used. If you cite different pages from the same book at different points in your paper, simply give details about the book in the reference list and put the pages cited in the text, as in the examples of Mungai 1990 above. If you are citing a whole book, include the total number of pages.

Examples of different types of references

JOURNAL ARTICLE

Arnold P. 1990. Title of article. *Journal of Soil Science* 55:222–34.

Atta-Krah AN and Sumberg JE. 1988. Studies with *Gliricidia sepium* for crop/livestock production systems in West Africa. *Agroforestry Systems* 6:97–118.

BOOK

Arnold Q. 1980. *Title of book*. New York: Wiley.

Ruthenburg H. 1976. *Farming systems in the tropics*. 2nd ed. Oxford: Clarendon Press. p 157–84. [when citing only certain pages in the book]

CHAPTER IN BOOK

- Youdeowei A. 1980. Title of chapter. p 222–34. *In*: Taylor B and Mungai C eds. *Title of book*. New York: Wiley.
- Singh GB. 1987. Agroforestry in the Indian subcontinent: past, present and future. p 117–40. *In*: Stepler HA and Nair PKR eds. *Agroforestry: a decade of development*. Nairobi: ICRAF.

PUBLISHED REPORTS

- Botswana Ministry of Agriculture. 1980. *How short people can plant tall trees*. Gaborone: Dryland Research Station.

If the publication is a serial, the series title and number will help locate it. Give this as additional information in a separate ‘sentence’ between the title and the facts of publication, but do not italicize.

- Botswana Ministry of Agriculture. 1980. *How short people can plant tall trees*. Helpful Leaflet 99. Gaborone: Dryland Research Station.

UNPUBLISHED REPORTS

Do not italicize the title of ‘grey literature’, unpublished reports.

- Huxley PA. 1986. Rationalizing research on hedgerow intercropping: an overview. ICRAF Working Paper 40. Nairobi: ICRAF. p 66–75.
- Richardson J and Richardson D. 1985. Agroforestry in the Pacific Islands. Working Paper WP-87-2. Honolulu, Hawaii: East-West Center.

PERSONAL COMMUNICATIONS

Personal communications are not included in a reference list. As there is no way a reader can check them for further information, there is no point in listing them. They are simply listed in the text: (Anthony Youdeowei, pers. comm.) [*or* personal communication].

Note that some journals do not permit inclusion of unpublished reports in a reference list. They must then be cited in the text in the same way as personal communications: (Anthony Youdeowei 1993 unpublished report).

Sources for reference rules

Council of Biology Editors, Style Manual Committee. 1994. *Scientific style and format: the CBE manual for authors, editors, and publishers*. 6th ed. New York: Cambridge University Press.

O'Connor M. 1992 With reference to references. *European Science Editing*, no. 47:4–6.

8

Using tables to present research results

Purpose

This unit will help training participants to:

- ❑ recognize the faults in poorly prepared tables
- ❑ construct well-designed tables

DATA THAT HAVE BEEN collected and analysed in a scientific investigation are presented in the Results section of a scientific paper. These data represent the research findings and may be presented as tables, graphs, figures or photographs (see unit 9).

- ❑ Tables are good for presenting precise numerical data.
- ❑ Graphs are best for illustrating trends and relationships among sets of variables.
- ❑ Figures and photos give vivid evidence of research findings.

Preparing tables

A table is a systematic arrangement of data or information in a format that allows the reader to observe variations or trends and to

make comparisons. Generally a table consists of most or all of the following elements:

- number and title
- column headings
- stub, or row headings
- field, or body of the table
- a footnote

Tables may be constructed using numbers as in table 8.1 (which also names the parts of a table) or with symbols as in table 8.2, with a mixture of words and numbers (table 8.3) or with words only and no numbers (table 8.4). These examples show the variety of ways in which different kinds of information can be communicated through the construction of tables. The choice of the method adopted depends on the nature of the information to be communicated.

Table 8.1. Rice production in East Africa ← *title*

<i>column headings</i>	Country	Growth rate ^a			Production ^b
		1970–90	1981–90		1988–90
	Kenya	3.62	4.71	<i>body</i>	54
	Madagascar	1.05	1.98	<i>or</i>	2310
<i>row headings or stubs</i>	Malawi	3.41	1.99	<i>field</i>	40
	Somalia	14.50	-3.15		16
	Tanzania	9.00	15.65		692
	Uganda	4.59	6.75		20
	Eastern Africa	2.16	3.93		3137
<i>footnotes</i>	<i>Source:</i> Rice trends in sub-Saharan Africa (WARDA 1992)				
	^a growth rate %				
	^b production '000 t				

GUIDELINES

- Always state the unit of measurement, usually in the SI system. If non-metric units are used in the investigation, convert to metric units for publications.
- If percentages are used in some cases, for example, describing solutions, distinguish between percentage by weight (w/w) or percentage by volume (v/v).
- Use a zero (0) when writing data values less than 1, for example, 0.25 kg.

Table 8.2. Weighting of some environmental constraints to irrigated rice production in the Sahel as a function of seasonal and cultural factors

Stress factor	Seasonal problems			Aggravated by			
	CDS	HDS	WS	Poor WM	Long CD	RR	DS
Cold nights (seedling stage)	++	+	0	0	0	++	0
Cold nights (reproduction stage)	+	0	+	0	+++	++	0
Hot days (reproduction stage)	0	++	0	0	+	+	0
Salinity / sodicity (evaporative residues)	++	++	+	++	0	0	0
Salinity/ sodicity (rising groundwater)	++	++	+	++ ^a	++ ^a	++ ^a	0
Weed infestation	+	+	+	+++	0	+	++
Bird damage	++	++	+	0	0	++	++

CDS - cold-dry season. HDS = hot-dry season, WS = wet season, WM = water management, CD = crop duration, RR = rice-rice double cropping, OS = direct seeding
 0 = neutral, + = yield reduction, ++ = severe yield reduction likely, +++ = possibility of total crop failure

^a effects with long-term environmental consequences

Table 8.3. The species of *Oryza* in Africa

Species	2n	Genome	Origin
<i>O.sativa</i> cultivated	24	AA	Asia
<i>O.glaberrima</i> cultivated	24	A ^g A ^g	West Africa
<i>O.stapfii</i> (weed species)	24	A ^g A ^g	West Africa
<i>O.barthii</i>	24	A ^g A ^g	West Africa
<i>O.longistaminata</i>	24	A ¹ A ¹	Tropical Africa
<i>O.brachyantha</i>	24	FF	West and Central Africa
<i>O.eichingeri</i>	24	CC	East and Central Africa
	48	BBCC	
<i>O.punctata</i>	24	BB	tropical Africa
	48	BBCC	
<i>O.schweinfurthiana</i>	24	BBC	tropical Africa

Source: Adapted from Ng and others (1983), Takeoka (1965)

- Use powers of 10 to avoid numbers with strings of zeros: 39 200 000 should be written as 3.92 x 10⁷. For column headings, follow the designation of units with '000 to indicate thousands, and use 42 as the entry for 42 000.
- Avoid using a dash (-) in tables, but rather indicate whether no data were available, the item is not applicable, or whatever may be the circumstances, using footnotes if necessary.

Table 8.4. Short-term trainees at WARDA's research stations at M'Be, Côte d'Ivoire, and St Louis, Senegal, 1993

Name	Country	Institution	Discipline
<i>Upland/Inland Continuum Programme</i>			
OM Kuller	Netherlands	Agric. Univ. of Wageningen	Agronomy
C Groen	Netherlands	Wageningen	Agronomy
D Hartkamp	Netherlands	Agric. Univ. of Wageningen	Agronomy
BN Diane	Mali	Station de Recherche Agronomique de Sikasso	Pathology
<i>Sahel Irrigated Rice Programme</i>			
S Ducheyne	Belgium	Univ. of Leuven	Soil Science
A Leyman	Belgium	Univ. of Leuven	Soil Science
MM Gueune	Senegal	Univ. CAD	Entomology
<i>Farm Management</i>			
N Puillet	France	ORSTOM	Agronomy
PKJ Gboko	Côte d'Ivoire	ENSTP	Urban planning
VK Koffi	Côte d'Ivoire	ENSTP	Drafting
M Fofana	Côte d'Ivoire	CET	Auto-mechanics
FI N'Guessan	Côte d'Ivoire	CET	Mechanical construction

- Do not cram too much data into a single table.
- Give the table a clear and concise title, which immediately tells the reader its contents.
- The title should state precisely what the table shows, not what the table is about.
- Arrange the data in columns to make them easily understood.
- Make the column headings short.
- Data should be rounded for significance: 76.4, not 76.42796.
- Do not use numbers with multipliers in column headings because this can cause confusion.
- Do not use table to present scanty data that could be satisfactorily presented in the text. A rule of thumb is that the table field should contain at least 8 items.

- Use appropriate symbols to identify items that are explained in the footnotes.
- Every table in a manuscript for publication should have a number and be numbered sequentially: table I, table 2, and so on. Do not use modifiers for table numbers such as table 1a.
- Tables should be numbered in the same order as they are cited in the text.
- Tables should present analysed and summarized data, not raw data.
- A table should be able to stand by itself, be self-explanatory, and contribute to conveying the research presented in the paper.

Questions to help design good tables

- Why is the table included?
- What does the table show?
- Is the table complete in itself?
- Does the table stand alone without the rest of the text?
- Does the table relate appropriately to the text?
- Is the table well located and referred to within the text?
- Is the title clear, concise and relevant?
- Are the row and column headings accurate and appropriate?
- Have the footnotes been identified with appropriate symbols?
- Are the data in the table accurate?
- Have the data been presented in a logical manner to facilitate understanding?
- Is there too much data in the table?
- Have you checked that the totals and statistical information in the table are accurate?
- Is the table well designed?
- Have all the tables been properly numbered?

9

Using illustrations to present research results

Purpose

This unit will help training participants to:

- understand the basic principles of preparing illustrations for scientific reports
- recognize faults in badly prepared illustrations
- prepare illustrations from numerical data

ILLUSTRATIONS ARE VISUAL PATTERNS used to present information or data. They are frequently used in presenting scientific data because they present information in a way that is easy to read and understand quickly. As illustrations (often also called figures) are meant to present data vividly, they must be simple and clear so that readers can immediately get the message.

The major advantage of illustrations is that they present information in a form which otherwise would need many words. Remember the old saying, 'A picture is worth a thousand words'.

Characteristics of good illustrations

Good illustrations should be—

- simple and clear
- contain relevant legends
- independent of the text and each other
- visually appealing, not crowded
- organized in the way they present data

Types of illustrations

Scientific papers commonly use a number of types of illustrations:

- Line graphs demonstrate relationships among data or dynamic comparisons (fig. 9.1).
- Bar and pictorial graphs compare quantities (figs. 9.2, 9.3).
- Pie charts show proportions of a whole (fig. 9.4).
- Photographs are accurate representations taken with a camera.
- Flow charts show a complicated process or system (fig. 9.5).
- Maps may show the distribution of quantitative or qualitative data or illustrate research sites or other locales (figs. 9.6, 9.7).
- Line drawings illustrate objects, specimens or represent data (figs. 9.8, 9.9)

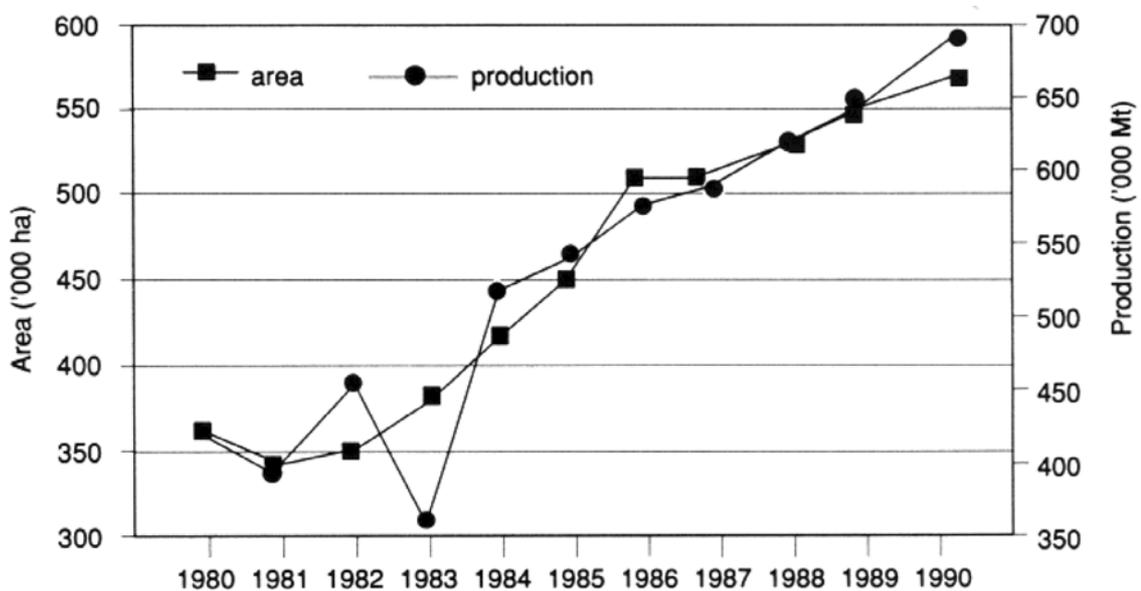


Figure 9.1. Rice production and area, Côte d'Ivoire. [line graphs illustrate relationships and make comparisons]

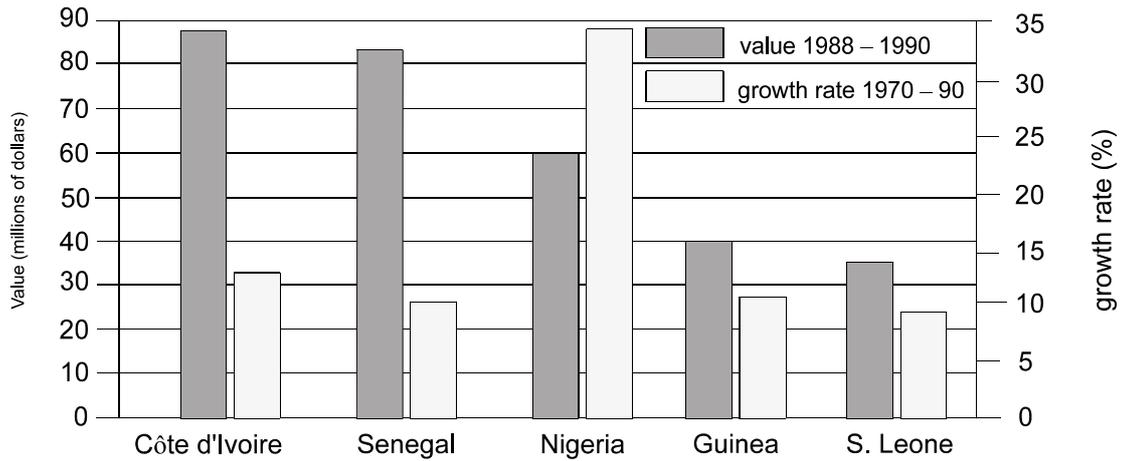


Figure 9.2. Growth rates and values of imports in major rice-eating countries in west Africa [bar graphs are good for visual comparisons]

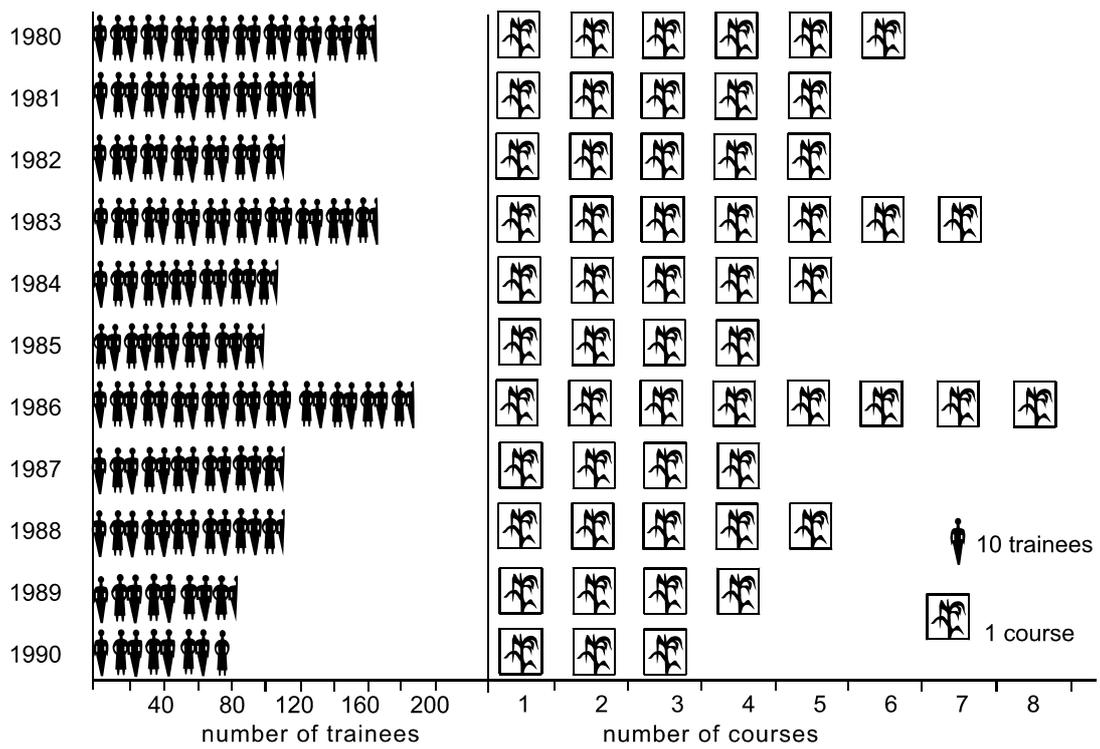


Figure 9.3. Number of people from national programmes by WARDA, 1980–90. [pictorial graphs also illustrate comparisons, but care must be taken not to distort the representations]

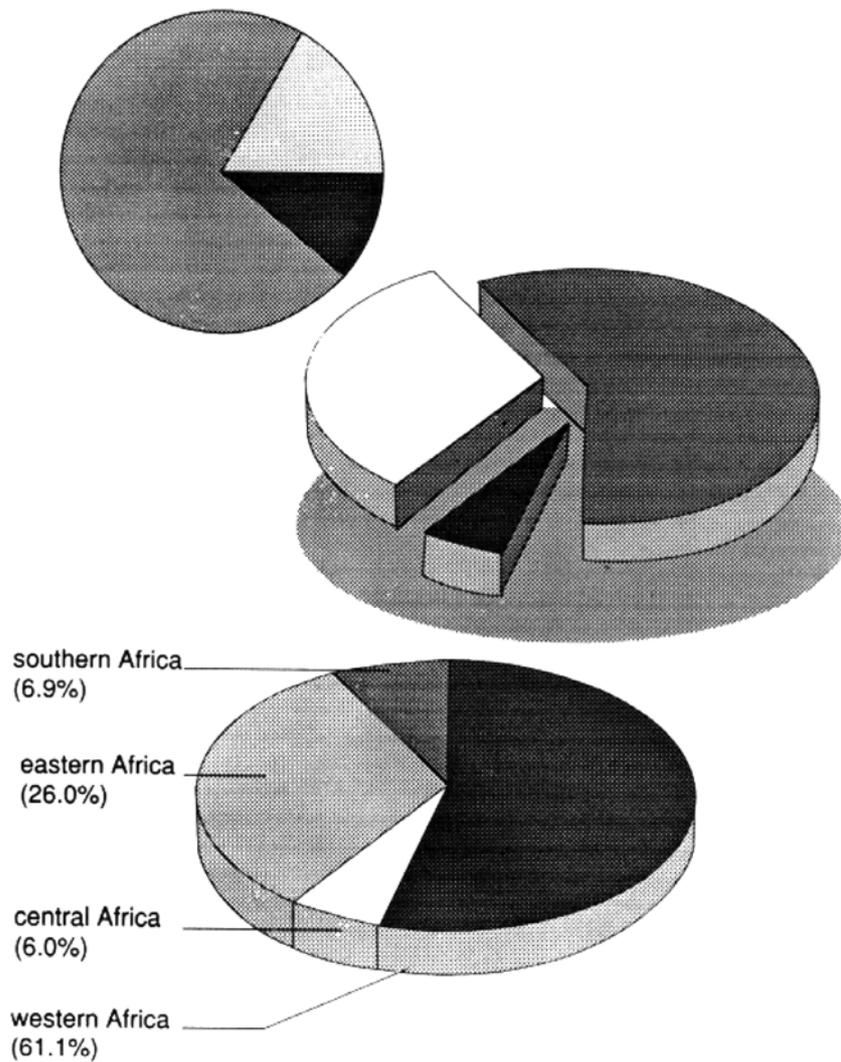


Figure 9.4. Total rice consumption in Africa, average 1988-90. [different forms of pie charts can be used to show proportions]

Hints on making illustrations

Scientific illustration is a profession, but you do not need to be a professional illustrator in order to make usable illustrations for your scientific papers. The most important issue is to decide what is to be illustrated, and answering the question: 'How best can the data or information be presented in a pictorial form?'

Examine the data carefully and decide what should be illustrated and which type of illustration best suits the data or the information you wish to present.

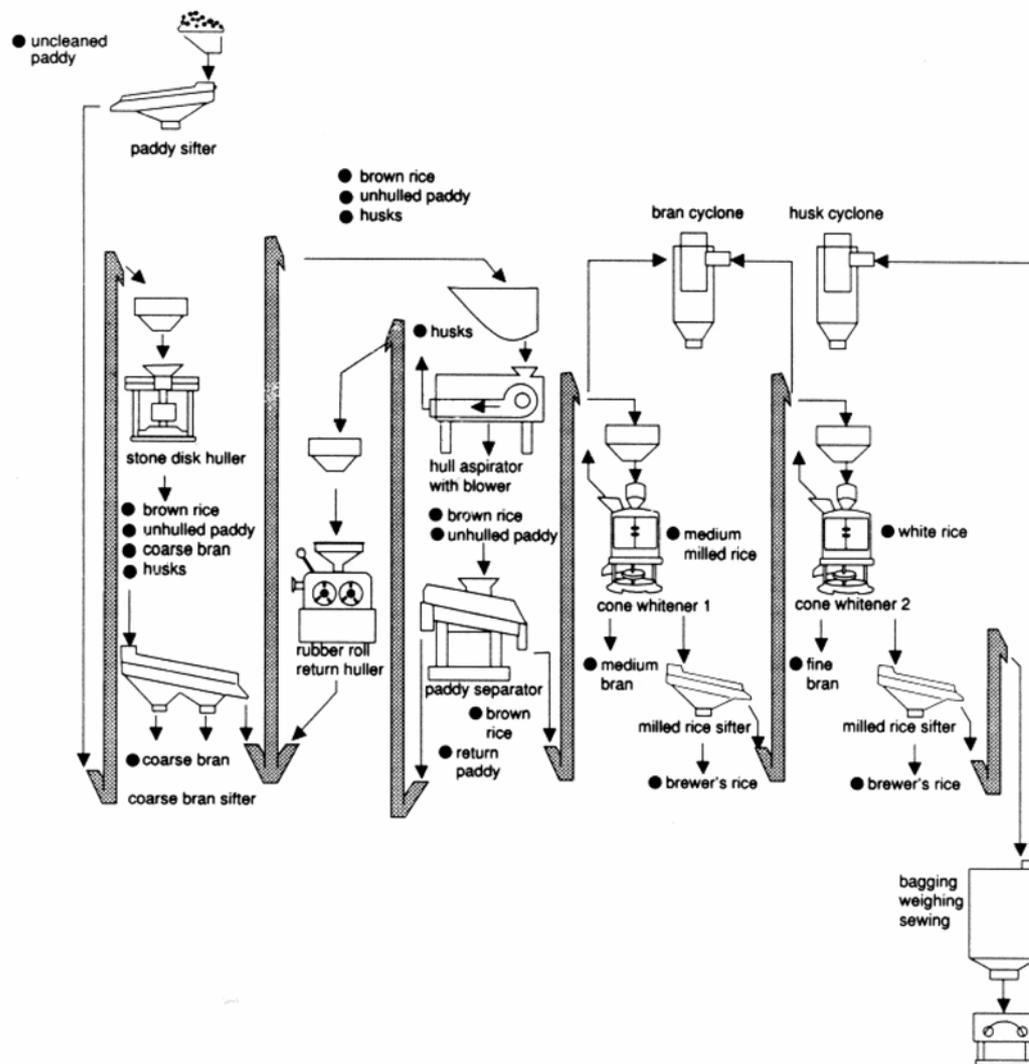


Figure 9.5. Rice milling process using a disk huller. [flow charts can make a complicated process clearer]

EXAMPLES

- Choose a line graph if you wish to demonstrate the relationship between two data sets, or a dynamic comparison over time.
- Use a flow chart to explain a process or system.
- Use a pie chart to compare sizes or proportions of components of a system.
- Use histograms to show frequency distributions of observations for each class of variable such as weights or crop yields.

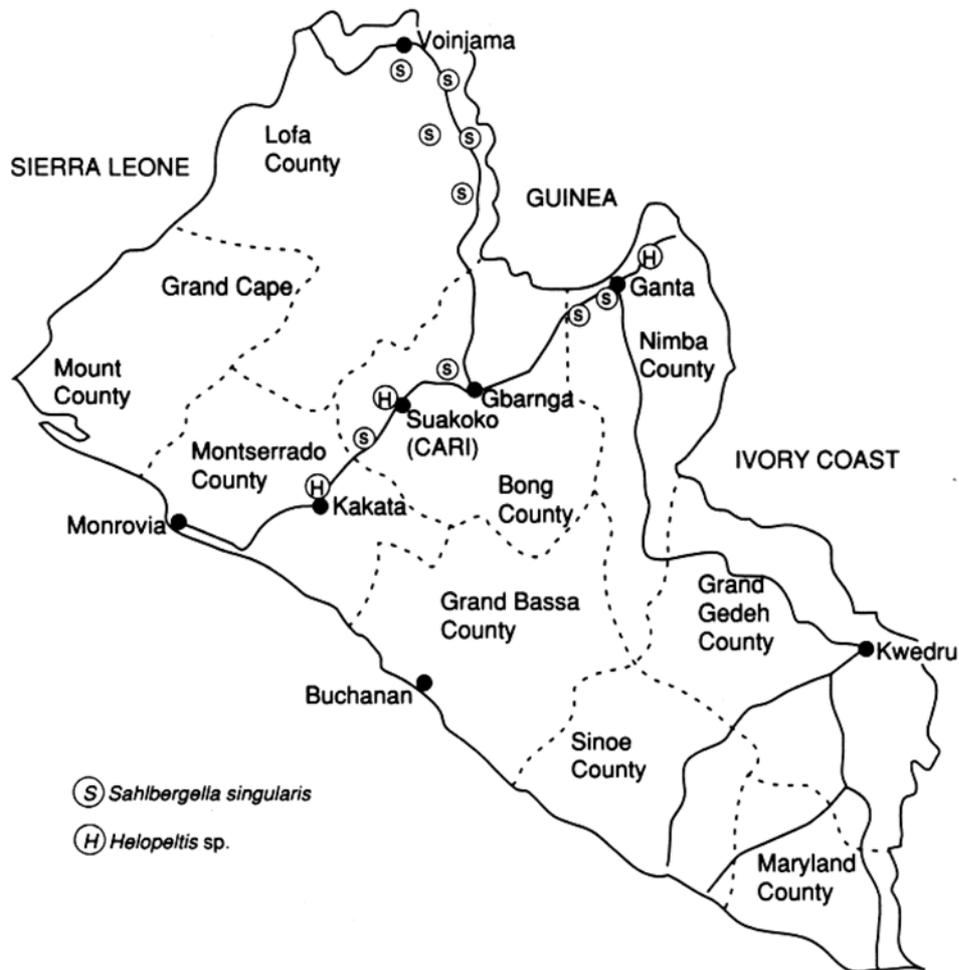


Figure 9.6. Distribution of economically important cocoa caspids in Liberia. [maps can show locale or distribution – or both]

- Use a thematic map to show the pattern of an experimental layout, or a geographic map to show the distribution on insect pests, for example, over a country or region.
- Use photographs to show the actual appearance of a specimen or something else you wish to describe.
- Use line drawings to illustrate objects or specimens or to present numerical data.

Graphs

Make your figures simple enough so that the reader can get your message instantly. A figure that tries to show too many things usually ends up not showing anything clearly. The figure you

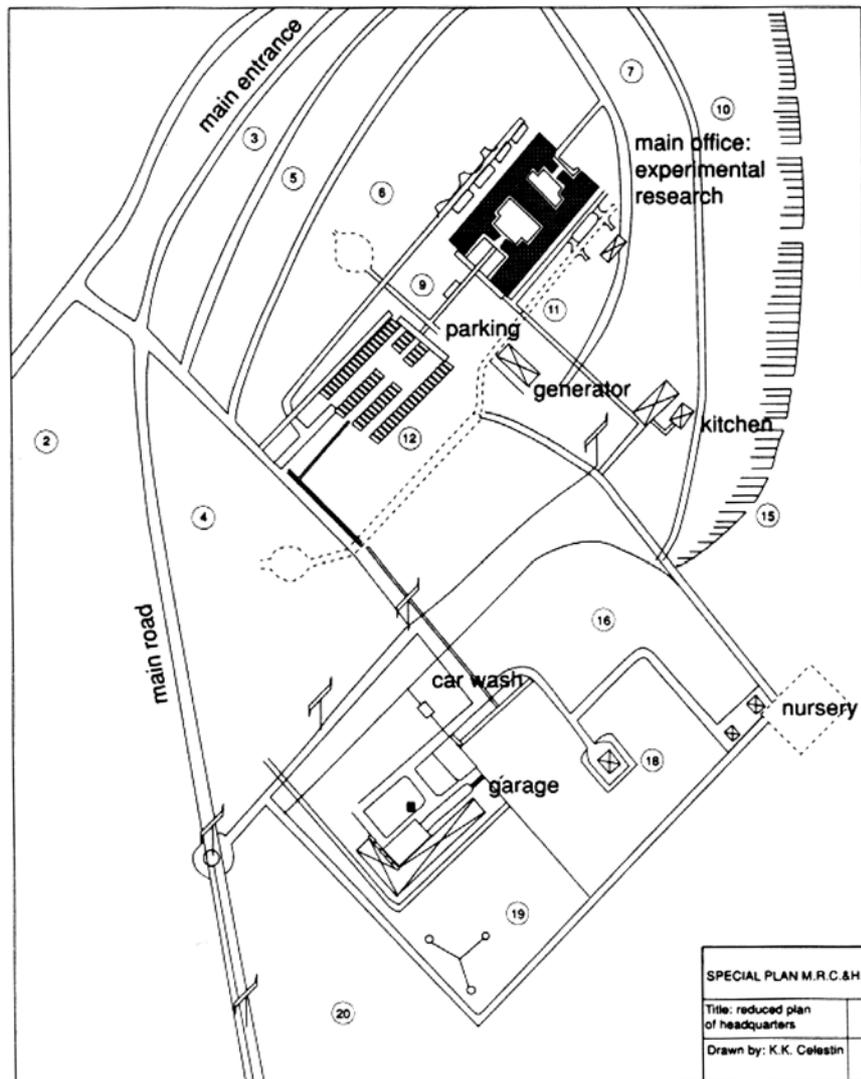


Figure 9.7. WARDA's M'Be site. [reference map to illustrate a research site]

submit should be drawn and lettered neatly, because usually it will not be redrawn. The figure you submit will be the figure published, if it is published at all.

Fortunately for those of us who are not artists, computer graphics make submitting a neat, well-lettered, well-presented figure a relatively easy accomplishment. Many software packages are now on the market, including the popular and easy-to-use Harvard Graphics. Graphs are usually prepared for publication or for an oral presenta-

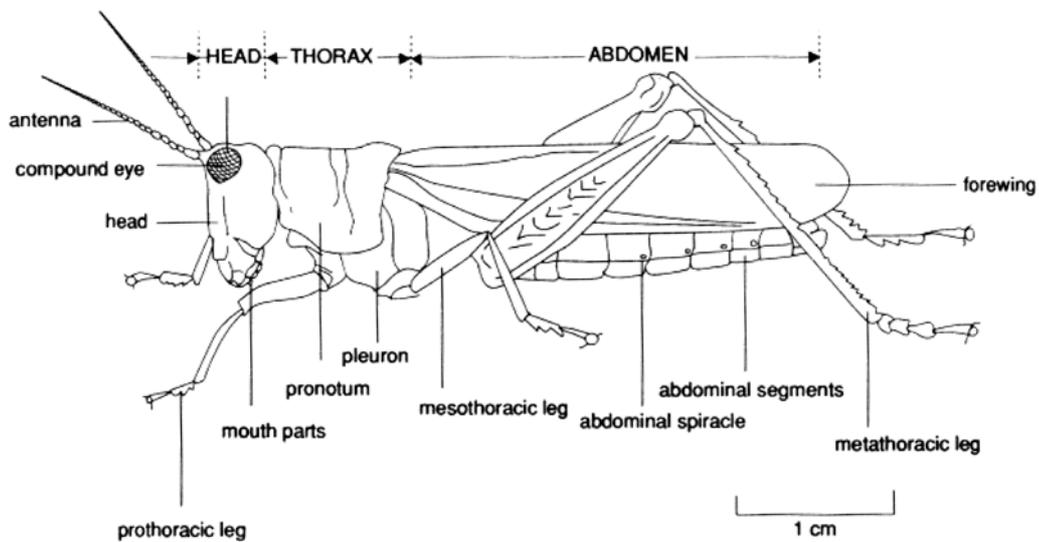


Figure 9.8. Parts of a grasshopper. [line drawings are useful to illustrate specimens. . .]

tion using an overhead projector. For publication, the graph is in black ink on plain paper, although a bar graph may have several different patterns. For a talk, the graph is made on acetate in colour.

Pointers

Put each figure on a separate page. The editor will incorporate each figure into the text at the most appropriate place on the page of the publication. Supply a good, sharp original. If you are using a computer printout, it must be done on a laser printer, so that the blacks are black and the lines sharp and clean. Keep your graph as clean as possible. For publication, use only half a frame (as shown on the example here) instead of a box all the way around your graph.

Some authorities strongly urge that all tick marks be placed inside the frame; others urge just as strongly that they be placed outside. Check the style of your target publication. Your lettering should not be overpowering. In Harvard Graphics, size 2.5 is good for axes and labels for publication; for overhead transparencies, which are read at a distance, try size 5 or 6. For publication, simply type in your caption below the graph. For overheads, create your figure title as you are making your graph: place it above or below your graph.

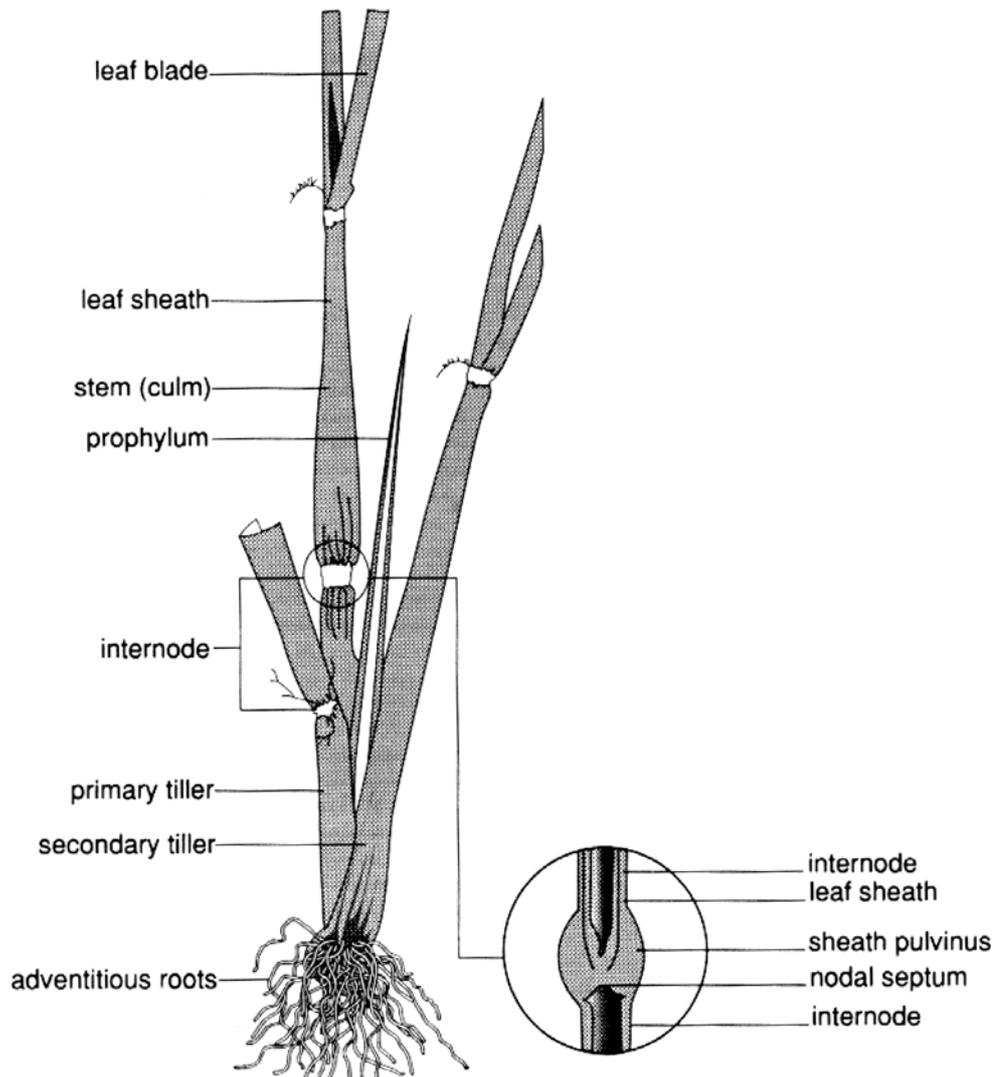


Figure 9.9. Rice plant and detail of section through a node. [. . . and can illustrate details difficult to show in a photograph]

Remember

A graph or a figure tells its own story. Do not repeat everything that your audience can see from the illustration just as if it were not there. But it is good to draw attention to important points that the graph illustrates. The two elements, text and figure, should complement each other.

Scanned images

You may have other types of figures in mind. A scanner can digitize a line drawing or an illustration in a book or journal and reproduce

it on a page for publication. You may decide that photographs are the most appropriate type of illustration for your paper. The photograph must be in black and white, with good contrast between the blacks and the whites and a good gradation of grays in between. It is often difficult to use a photograph to illustrate a particular point. It may be easier to illustrate the point with a line drawing, but a good photograph can also be effective.

Oral presentation of research results

Purpose

This unit will help training participants to:

- identify the main faults in a poor oral presentation of research results
- improve their skills in preparing presentations for scientific meetings
- develop more effective techniques for making scientific presentations

THERE ARE MAJOR DIFFERENCES between a scientific article written for reading and one written to be read at a scientific meeting. In a written article, the reader has the luxury of lingering over the text to absorb the material, even going back to a previous paragraph or page to help grasp the significance of something later in the text. But in an oral presentation, the listener may have only one chance to understand the material that is being presented; thus the speaker needs to present each idea clearly—and perhaps even repeat key points.

Some people argue that it takes about 3 minutes to put across a new idea, and therefore a speaker must repeat and expand on an idea several times for the audience to get the message. In most scientific meetings, each speaker (except invited keynote speakers) is normally

allowed only about 15 minutes. The speaker should allow 2 minutes for an introduction and 1 minute for the conclusion, which leaves about 12 minutes for the actual presentation. This is a short time to present research work that probably took several months or seasons to complete. It is not an easy task. Scientists wishing to present their work at meetings should take the time to prepare adequately.

Here are some hints about how to prepare and present a scientific report at a meeting.

Preparation

- Speaking at a normal speed, speakers can deliver about 400 words in 5 minutes. This is about 2 to 2½ double-spaced typewritten A4 pages. Therefore, for a 15-minute presentation, your paper should not exceed 10 double-spaced, typewritten A4 pages, plus your illustrative material. The text should contain only your major ideas. Avoid citing references and acknowledgements—these will waste your precious time.
- Prepare or select your illustrative material such as slides or overhead transparencies very carefully. Ensure that it is relevant to the subject and will reinforce what you say.
- Double space the text, or use large letters if your computer printer can handle them, so that the text is easy to read. Do not crowd too much data into the visual materials.
- Rehearse with a colleague so that you know your presentation will fit into the allotted time.
- Put your illustrations in the order you will use them and number them accordingly.
- If you are using slides, mark them so you know which way they go into the projector tray.
- Dress neatly and well.

At the conference room

- Before your presentation, load your slides into the projector and do a trial run to ensure that they are all loaded correctly in the right sequence. A preceding coffee or lunch break is a good time to try this.
- If the projector is not working correctly, inform the conference organizers immediately so they can either fix it or bring in another one.

- Check that the projector is sitting solidly on its stand.
- Make sure that you know how to manipulate the projector, especially the remote-control mechanism.

During you presentation

- Speak clearly *to* your audience, not *at* your audience.
- Present a single idea or fact in a variety of ways by varying your construction and voice. Remember, present only one new idea every 3 minutes and repeat this in other ways to permit your audience to pick up the idea.
- Adopt a simple conversational style, do not shout.
- Be relaxed and confident. Look at the audience, not at the floor or out the window, no matter how shy you may be.
- Allocate your presentation time—Introduction 35%, Methods 40%, and Results and Discussion 25%.
- Pause after each new slide or transparency is projected to allow time for your audience to absorb the new material.
- Do not distract your audience by pacing up and down the room, tripping over the microphone cord, or fiddling continuously with the microphone. If you have to use a microphone, do not place it too close to your mouth because the sound quality will be poor.
- Get your message across clearly. Tell your audience what you are going to say (Introduction), say it (Methods, Results, Discussion), and then tell them what you have said (Conclusion).
- If possible, complete your presentation 2 minutes before your time is up. Do not get into a running battle with the chair, who will be struggling to stop your talk. Give other speakers a fair chance to present their work.
- At the end of your presentation, do not forget to thank the chair and the audience for their attention.

11

Using posters to present research results

Purpose

This unit will help training participants to:

- understand the basic principles in the use of posters for the communication of agricultural research results
- plan and design a poster presentation of research results

AGRICULTURAL RESEARCH RESULTS are sometimes presented as posters, which are usually mounted on walls of rooms or along the corridors of research institutions.

During national and international conferences, it is common to find many posters on display. In some cases, special poster sessions are organized where scientists stand by their posters to answer questions from people reading them.

In a way, a poster is a shortened form of a research paper, which is presented visually on one or more large sheets of paper. A poster

can also be effectively used to present pictures that tell a full story or a research activity as well as the results.

The main point about posters is that the information is provided through the use of visuals in a well-coordinated and organized combination of text and illustrative matter.

A good poster should

- be simple and highly informative
- be easy to read and understand with relevant legends
- be visually appealing and attractive, to encourage people to read it
- contain text and illustrative matter harmoniously combined to produce an effective presentation
- tell the story completely

The major elements in a poster

The following three examples illustrate how the subject matter of a poster determines its elements.

EXAMPLE 1

A poster that reports the results of research would contain the following:

- title of poster—text
- introduction—text
- materials and methods—text and illustrations
- results—text and illustrations such as graphs, histograms, photographs, line drawings, or actual specimens
- conclusions—text and illustrations

EXAMPLE 2

A poster that describes the life cycle of the rice stem borer and its damage to rice would contain the following:

- the life stages of the rice stem borer
- clear photographs or drawings with short descriptive legends
- rice plants at different stages of damage by the rice stem borer
- photos or drawings with short descriptive legends

- distribution of the rice stem borer within the geographical region of cancan, e.g., a well-labelled map of West African countries to indicate occurrence in different countries

EXAMPLE 3

A poster on the agricultural information services in WARIS, the West Africa Rice Information Systems project of WARDA, in Bouaké, Côte d'Ivoire, might contain the following elements:

- colour photographs of the WARDA library and documentation centre showing shelves with books and journals
- photos of WARDA library staff involved with in-house document production and distribution of documents to rice scientists
- text that explains briefly the range of agricultural database facilities available at WARDA's library and documentation centre
- text that describes briefly the range of information services on rice science provided by the WARIS project
- photos of the CD-ROM agricultural databases available at WARDA

Preparing a poster

Before you start preparing a poster, decide on the precise topic and subject matter you wish to communicate; then proceed to plan the poster in the same way that you plan the writing of a research article.

Write the complete text of the story. Revise it thoroughly until you are satisfied that all the information you wish to convey has been included. Edit the text conscientiously to keep it brief.

Note the parts of the text that you wish to illustrate. Approach a graphic artist and describe exactly what you wish to show in the poster. The artist will produce a design of the poster for you to review and approve. Study this design carefully. When you are satisfied with it, give approval for the artist to proceed with production of the final poster.

If you do not have access to a good graphic artist, you can prepare a good poster yourself. Here are a few hints to assist you in preparing a poster for a conference poster session.

Plan, write and edit your text. Decide what you want to illustrate. Arrange to make large prints of the photos you need. Make a large sketch of the graphs and diagrams you plan to include in the poster. The importance of the material being illustrated will determine the relative sizes of your illustrations.

Set the text in large type, about 14 to 18 point size. Make the text concise and brief. Paste the text groups on separate sheets of paper; the sizes will vary according to the amount of text.

Check on the size of your poster. If you are preparing the poster for a conference, the organizers will give you this information. Prepare a rough layout diagram to scale, as illustrated on the next page, indicating the exact place where each element will fit in the final poster. Using this diagram as a guide, measure the actual sizes of the text and illustrative materials and fit them on a full-size dummy of the poster sheet.

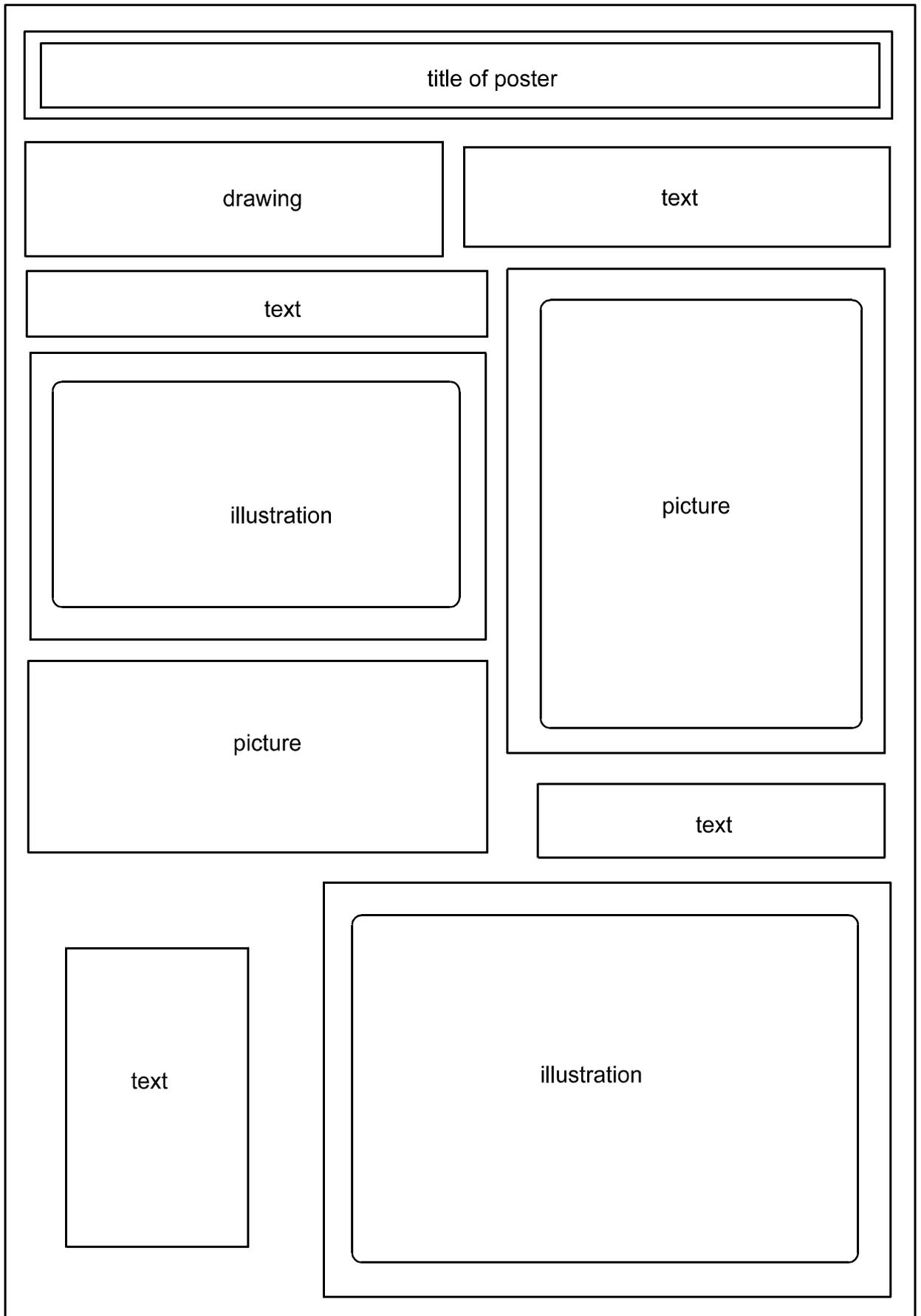
Paste the text on separate small sheets of paper and cut out the extra paper areas. Make sure to paste the section in straight lines vertically and horizontally.

To enhance the appearance of your poster, you can print the text on coloured paper or print it on white and then paste the text blocks on contrasting colour paper such as black, green, orange or red. Photos, drawings and graphs can also be pasted on contrasting colour backgrounds.

The layout plan on the next page is a typical example.

Carry the component parts of your poster to the conference and set up the poster there, using the poster layout plan as a guide. When you assemble your poster, be sure to mount all the elements ***straight and neatly***. A carelessly mounted poster attracts little attention and readership.

Poster layout plan



12

Writing proposals and reports

Purpose

This unit will help training participants to:

- analyse the elements of a suitable and successful project proposal
- develop and write realistic project proposals that meet the needs of potential in-country and external donors

PROJECT PROPOSALS ARE in essence mini-research papers that have not reached the stage of actual practice. They have a number of well-defined elements that if put together sensibly and carefully should result in successful funding for the project.

Just as in approaching the writing of a research paper, you should work out the target of your proposal before you start writing it. Different donors have well-defined priorities and specific requirements for their project applications. Fortunately most have comprehensive handbooks that detail how a proposal should be constructed. Below is a list of the main elements that usually form a project proposal.

title
project leader

abstract

analysis of the problem and
justification
objective and hypothesis
time frame
methodology

statistical treatments
project work plan
expected outputs
collaborators
budget

Title

As with a research article, the title is one of the most important parts of the proposal. It will immediately attract or lose the interest of any potential donor, so it should be concise and above all accurately reflect the content of the project.

Project leader

With most proposals, you will need to nominate a project leader and include a curriculum vitae. Many donors have clear requirements that are detailed in the application forms. If none are given, give at least the name, institutional and correspondence address, details of qualifications, a list of posts held and a brief list of publications.

Abstract

Assessors will base their preliminary judgement of the immediate suitability of your project to their needs on your abstract. In a few sentences you should justify the project, outline your work plan and describe the expected outputs and their significance.

Analysis of the problem

Look at the background of what you want to do, say briefly why you think the work should be done and relate it to what is already known about the problem.

Objective

State what you want to achieve by doing the work. Your statement might have two levels, for example, a long-term development objective to which this project will contribute and an immediate objective that project activities will achieve.

Time frame

Early on in the proposal you should give the duration of the project. This is different from the research or work plan or timetable of activities.

Methodology

Basically similar to the 'Methods and materials' section of a research paper, although a little less detailed, the methodology section should outline the experimental design and the procedures and protocols you will use, as well as describe the locations and inputs you will employ.

Statistics

Some donors need a description of the statistical analyses you intend to employ. These will obviously correspond with your experimental design.

Research plan

Describe the timetable you intend to follow, and specify the way that one output from a project will lead on to another. This is a way of illustrating the assumptions you are making about the project and allow assessors to judge its feasibility.

Expected outputs

Outputs must above all be significant, but also finite, measurable and definite. Don't say that you intend to increase productivity in the Sahel region but rather aim to raise productivity of a specific crop by a predicted amount in a precise region over a finite amount of time. This is one of the primary faults of many project proposals. The outputs are not clearly worked out and consequently it is impossible to say when the project has achieved its objectives.

Collaborators

List any in-country or international collaboration you foresee or intend.

Budget

The budget must be realistic, detailed, and accurate, listing personnel expenses, equipment, supplies, travel and any other significant expenses. Do not include large amounts for contingencies or vague purposes. Also include a spending plan of when money will be needed through the life of the project. Cost each item carefully and allow for inflation. You may have to justify travel to meetings separately, outside of project travel.

Writing research reports

If your research proposal has been well written and it is successful, you receive a grant from the donor to execute the research project. The donor will expect to receive reports on the progress of the research. In many project proposals, the reporting schedule is included as a guide for submitting reports. The two kinds of reports that donors normally expect are (1) progress and final reports of research project activities and (2) a financial report.

The scientist usually prepares the research report; the financial report is prepared by the accountant of the institution but in consultation with the scientist.

In addition to preparing research reports for donors, scientists in research institutes are expected to prepare periodic progress reports, as well as annual reports of their research. So the major kinds of research reports that scientists normally write are—

- progress reports of research
- end-of-project report
- annual report of research

Preparing research reports

Before writing a research report, you must make decisions about—

- the kind of report to be written, whether a progress report, an annual report or a final project report
- the particular aspects of the research work that are mature enough to be reported
- the pattern of the report
- the required schedule for submission of the report

Some donors provide guidelines for preparing reports of the research that they fund. In this case, you should follow strictly the format recommended. It is in your own interest to do so, to please the donor and remain in the donor's good books to receive more research grants.

When no special format is provided, research reports are usually prepared according to the IMRAD logic described in unit 3.

The outline of a research report should therefore consist of the following elements:

title	results
name of author(s)	discussion and conclusion
address of author(s)	acknowledgements
abstract	references
introduction	appendix
materials and methods	

Note that the structure of the research report is similar to that of a research paper except that a research report may contain an appendix, which could be the mass of data from which the text tables were prepared or some other material to which reference is made in the body of the report.

The research report should be organized to conform with the objectives and concepts in the project proposal.

Effective writing of a research report requires careful planning, just as you planned the research activity or as you plan the research paper you write for publication. In writing research reports, you should therefore adopt the procedures described for writing a research paper (unit 3).

One final tip! In every report, remember to acknowledge the financial support received from the donor for carrying out the research project.

The importance of the media and popular writing

Purpose

This unit will help training participants to:

- ❑ understand why they need the media
- ❑ understand the different audiences and kinds of media
- ❑ understand the special requirements of writing for a broad audience
- ❑ write a news story and a simple feature article

WRITING POPULAR ARTICLES may not be a high priority for many scientists. Some may ask why this unit is even included in a manual on scientific style and English in a research paper. Some researchers may think that they and their research are somehow removed from the mainstream—from the general public and the media.

In fact, most scientists rely very heavily on the media—newspapers, magazines, radio, television and newsletters—to keep themselves informed about what is going on in disciplines other than their own. It would be impossible to keep up to date on all the latest scientific

findings in all disciplines were it not for the media, which boil down research results and make them easily and quickly digestible for a broad audience of non-specialists.

But that is not the only reason that scientists need the media. The media reach the public as a whole. Within the public are audiences that are crucial to researchers:

- donors, who decide what research (and which researchers) get funding
- taxpayers, who foot the bills and elect the people who become donors
- policymakers, whose decisions may be influenced by research findings
- educators, trainers and extension officers, who transmit research findings
- user groups, who benefit from research findings
- potential collaborators, who may want to work jointly on future projects

It is unlikely that funding will be reduced for research that has been widely publicized in the media, where it is shown to be interesting and relevant in solving problems.

Which media and for whom?

Scientists need the media, so they also need to learn how to interest the media in their work and how to write basic articles that convey information—clearly and simply—to a broad audience.

The most common media outlets are

- newspapers—daily, weekly
- magazines—weekly, monthly, quarterly
- television—news items, documentaries, interviews
- radio—new items, documentaries, interviews

Story formats

Common formats for material are

- the press release—general distribution about what happened or is about to happen

- the news story—specific distribution to certain target newspapers
- the magazine article—less timely than a news article, usually longer
- the feature article—description of an interesting subject, usually does not depend on timeliness
- the editorial—an expression of the publication's opinion
- the opinion piece—commentary expressing an opinion that is not necessarily that of the publication
- the documentary on radio or television (using sound, images, script and interviewees to tell a story)

Know your audience

Naturally, different publications have different audiences. Even daily newspapers cater for different groups of people. These range from the tabloids, which cater for readers of a certain income and educational level, to the serious highbrow papers that carry more indepth news items and analysis and more features. It is in the latter that serious articles on science are most likely to appear.

In most cases, journalists will approach a researcher for a story. Most of what appears in the media is written by information specialists—journalists, public affairs officers and professional writers. However, the press cannot know what's going on unless researchers also reach out to them—by, for example, inviting journalists to field days and workshops or by inviting them to their office or laboratory for a chat about the kinds of work they are doing.

Researchers can also write popular articles themselves for publication. Some of the most highly respected scientists regularly take the time and energy to write popular articles. Indeed, this adds to their stature in the scientific as well as the lay community.

Writing up research results in a popular and human way for the media does not trivialize or demean the work.

Just as you choose a scientific publication for your paper, so should you consider what kind of media, publication and audience would be interested in the kind of research you are doing. Consider why you are doing the research and how it can help change people's lives; these are questions the media will always ask.

To justify the use of an article in the mass media, a story must be of interest to a considerable portion—or at least a specific part—of the audience.

The audience will depend on what kind of publication it is:

- | | |
|-----------------------|--------------------------------|
| □ general circulation | □ specialized according to |
| □ local | subject, age, profession, etc. |
| □ regional | □ gender-specific |
| □ international | □ level of expertise or |
| □ specific language | specialization |

Writing popular articles is not as different from writing scientific articles as you might expect. You must, of course, write well. That means you must write draft after draft until your article is clear, simple to understand and free of jargon. You will need to keep your sentences relatively short and straightforward, but you should do this in good scientific writing as well. Most of what you covered in unit 3 is applicable in popular writing as well.

There are, of course, some basic differences.

Capture your audience

In popular writing you *do not have a captive audience* as you do in a scientific journal. Readers of scientific papers have usually made a special effort to find the journal and the paper and they will scan or read it through because they need the information it contains.

Readers of popular publications or media audiences generally happen upon your story *by chance*. This means your article or story must compete with many others to keep the reader's (or listener's or viewer's) attention. Your goal is not merely to communicate information; you must first capture your audience and keep them reading or listening or watching to the end. To achieve this, you must tell them an interesting story.

Headlines

To do this you should start with a title that captivates and intrigues the audience. You do not need to abstract your article in the title; if you do, your potential audience will have fallen asleep or will look for an article that promises more punch.

EXAMPLE

Assembling and evaluating indigenous knowledge for the enhancement of nutrient-cycling and land use through research into agroforestry systems in Kenya

TRY INSTEAD

Agroforestry—homegrown science from Kenya

EXAMPLE

Achievements in the collection of seed and successful establishment of several species of indigenous fruit trees of the Kibolo Forests in the Western Province of the Republic of Madawa

TRY INSTEAD

Out of the forest—indigenous fruit trees in West Africa

EXAMPLE

On-farm growth performance and biomass production of nursery stocks and stands of multipurpose trees on the small holdings under adverse and extreme drought and flood conditions in the mountainous district of Montanal in Southwest Region in Outer Mongolia

TRY INSTEAD

Tough conditions, tough trees

Writing news stories

Scientific writing usually starts off by introducing the topic, then in a logical step-by-step approach, it presents research and leads to a conclusion. The sequence is exactly the reverse in a news story. A news story in a newspaper begins with the most important points, or the climax. This is called the lead. Then the facts are arranged in decreasing order of importance. This is called the *inverted pyramid* form. The most important fact is at the beginning of the sentence, the most important sentence is at the beginning of the paragraph, and the most important paragraph is at the beginning of the story.

News articles report timely events, ideas or situations of interest to readers of a particular publication. There is always more news than space to report it. Thus, stories are shortened to fit the space available in the newspaper or magazine. Most news editors do not have time to read your article and rewrite it to fit the space. They 'cut from the bottom'. In other words, they will start chopping off paragraphs from the end of the story until it fits the space. This is why it is so important to put all the key facts in the beginning of the story.

The *key facts* to any story are the answers to six simple questions:

- Who? —a person may be widely known in the area, nationally or internationally. Also applies to organizations
- What?—the idea or event may be more interesting or significant than who is doing it
- Where?—interesting only if it is somewhere out of the ordinary
- When?—interesting only if the time is extremely important or unusual
- Why?—interesting when the reason why someone did something has a great deal to do with human interest
- How?—if something was done in an unusual or interesting way, or has never been done before

Of these six elements, 'why' and 'how' are often the most difficult to answer but may also be the most significant.

Features, opinion pieces and magazine articles

Features and articles (which are longer and more literary than cryptic news stories) are the most common format for science in popular publications. Most often such articles are between 1000 and 3000 words long. and editors expect you to keep to the number they request.

Good features capture and hold the reader's attention quickly, usually with the first two or three lines. This is called the 'hook' and it often sketches a human story—perhaps that of someone whose life has been changed by research results. It can also provide context for and therefore show the importance of the actual research—if the article is about research into managed tree fallows, it might relate some startling statistics about declining amounts of arable land around the world.

The 'body' of the article contains the more detailed information on the actual research, when, where and why it was carried out, highlighting anything new or exciting in the way it was done. Even in the body, reference should be made to the ultimate purpose of the research, which will justify it to the public.

The conclusion of the article should tie together the story, much as it does in a scientific paper, but there is more room for human drama in a feature. Often, it is useful to return to the story used in the 'hook', showing how the research has changed someone's life, or helped solve a large problem.

Writing good feature articles is not easy—it is a craft that takes time to perfect. However, it can be a great deal of fun and it allows the researcher to be more 'human' and 'personal' than is permitted in scientific papers. It provides an outlet for creativity that many researchers have, and the writing process will often help clarify, for the researcher and the reader, why the research is important. This is always useful, particularly when writing research proposals to solicit funding.

Deciding what to write

Measure the facts you wish to communicate against the following:

- timeliness—how recently did it happen?
- proximity—how close is it to the audience and the point of publication or broadcast?
- importance—what is the significance of the story? who really cares?
- policy—how does a publication, radio or TV station view different events?

Components of popular writing

The opinions, attitudes and beliefs of readers shape their interests and reactions. People strive to reduce tension in their lives by seeking solutions, which makes them interested in certain elements reported by the media.

- conflict—all types of struggles of the human condition
- progress—improvements people make to the status quo
- oddness—rare, out of the ordinary ideas, events or situations

- human interest—ideas, events or situations that strongly affect human emotions. People are generally fascinated with what other people are doing

For example—a tree is not of intrinsic interest to the broad public; how human beings may use and benefit from that tree is.

14

Basic facts about photography

Purpose

This unit will help training participants to:

- ❑ understand the qualities of different cameras and relate them to task at hand
- ❑ employ techniques and equipment to produce photographs to illustrate their research papers

CAMERA SHOPS CAN BE absolutely baffling to anyone thinking about buying a new camera. The most important things to consider are cost, quality for the intended end use and where you will use the camera.

Most photographs that will be printed in a publication will not be magnified more than 4 or 5 times the size of the negative, so top-quality cameras are not needed for adequate results. However, the film size should be at least 35 mm—cameras that use size 110 film produce an image that is too small for adequate quality.

Type of camera

A 35-mm camera is good to use for the different types of pictures you may need to take of your research. Choose from among a single-

lens reflex (SLR), a rangefinder camera, or one of the point-and-shoot models, which are of surprisingly good quality. Most newspaper photos are taken with an SLR camera. Many of the point-and-shoot cameras, however, have a fixed focal length lens (usually about 35 mm, which is considered wide angle), although an increasing number have lenses that can be switched from wide angle to moderate telephoto. A few even have zoom lenses, which offer an infinite range between an upper and lower limit of focal length. Most of the small automatic cameras are perfectly adequate for taking pictures of plants, animals and people, assuming that you do not want extreme close-ups.

AUTO OR MANUAL EXPOSURE?

With a little care, an automatic camera will provide properly exposed pictures in most situations, but for more control, you should have a camera in which you can override the automatic controls. A small automatic camera should have an exposure lock, so that you can 'lock in' the exposure with a reading from one position and then take the picture from another angle using the same exposure. An automatic SLR should have a manual override.

AUTO OR MANUAL FOCUS?

Autofocus is OK especially for small cameras, but you should be able to lock the focus where you want it before reframing and shooting the picture.

Lenses

If you have an SLR, you may want to invest in a few additional lenses. The camera usually comes with a 50-mm lens. You may also want to consider buying a wide angle lens (either 28 or 35 mm) or a telephoto lens, up to about 135 mm. However, you can buy the SLR camera body without a lens and separately buy the lenses you want. You might want a wide-angle lens (24 mm, 28 mm, 35 mm) and a long focal-length lens (up to 135 mm). If you are planning to buy several lenses, a good rule of thumb is that each lens in a series should be about double the length of the previous one, i.e., 28 mm, 55 mm, 105 mm. Many of these lenses have macro capability, allowing you to take extreme close-ups to show detail.

You might want to consider a zoom lens, that is, one with a variable focal length. If you decide to buy a zoom lens, then you would not have to buy fixed focal length lenses within its range. A zoom lens is usually not much heavier than the standard 50-mm lens, but it is convenient because you don't have to worry about changing lenses all the time. One choice would be a 28- to 75-mm macro zoom lens. At 28 mm, you can take wide-angle landscape shots, the slight telephoto effect of 75 mm is fine for reasonable close-ups of people and animals, and the macro capability lets you get very close to a subject to show detail. Zoom lenses of a much wider range are available (such as 35 mm to 200 mm), but these may be either very expensive or of low quality if they are cheap.

Electronic flash

Today most automatic cameras accept electronic flash and control the exposure automatically so it is not necessary to fiddle around to adjust the exposure. If you are photographing a subject with strong backlight (if you are facing the sun, for example), then the flash can brighten the shadows in the picture. This is called fill-in flash. The technique is particularly useful when you are photographing people out in the bright sun. In this case there are dark shadows on their faces, especially if they are wearing hats, and a flash can be very useful. You may have to experiment a bit to learn to produce good exposures.

Do not fall into the trap of having to stand around waiting for the ready light to come on. Before you go out, check the batteries in the flash. Always take a fresh, spare set of batteries with you when you go out to shoot pictures.

Film

Do not use colour print film if you are taking pictures intended for black-and-white publication. The quality of the final printed result is almost never as good as if you had used black-and-white film. If possible, take two cameras, one with colour slide film (to be used when you make presentations), and the other with black-and-white film. Few journals today will print colour photographs unless the colour is absolutely essential to the scientific point under discussion. If you plan to publish colour photos, use slide film, *not* colour print film. However, if you end up with only a colour print of the particular subject you want to illustrate, do not despair—modern

printing techniques often manage to get good reproduction from a colour print.

The sensitivity of film to light is rated on either the ASA or the ISO scale. The higher the number, the more sensitive, or faster, the film is. Faster films, however, are usually more grainy than slower films, so the final result may be of a lower quality.

When you are buying film, always check the expiration date, or 'process before' date printed in hard-to-read type on the film box. If it is less than a year away, do not buy the film. Ask for fresher film, or go somewhere else.

Once you have bought your film, keep it in a cool place until you use it, even in the refrigerator or freezer, in the original, sealed package. If you are travelling in a car in the tropics there is not much chance to keep the film cool, but don't leave it in the boot (trunk) of the car or in the glove compartment, both of which get extremely hot. Also, don't leave the film in a closed car.

X-ray machines at airports, despite what all the signs say, do affect film, but the effects are cumulative. So if you travel through several airports, each time your film is x-rayed (whether it is unexposed or exposed), the effects of the x-rays add up and can ruin your film. Buy a lead-lined bag, or hand the film over the barrier and ask for a visual inspection.. Remember to keep your camera unloaded as you travel so that there is no film in the camera when it is x-rayed. Try to finish the roll of film in your camera before you begin to travel home so that all your film can be in a lead-lined bag.

SLIDE FILM

Film with an ASA (ISO) of 100 or less usually gives the highest quality slides. Faster films are usually grainier. Many photographers claim that Kodachrome 25 gives the truest and brightest colours, but it is too slow for convenient use—you almost always need a tripod for your camera. Your choice of film will depend primarily on the lighting conditions and whether or not you can use a tripod.

BLACK-AND-WHITE FILM

To use black-and-white film successfully, you need to think in monochrome because this film renders all colours as either black,

white or shades of gray. Contrast is the difference among the light and dark areas of the photograph and is the key to a good black-and-white photo. It is important that there is enough contrast to distinguish the detail in the picture, but not so much contrast that the details are washed out. If you are not sure if the photographic print is the correct contrast, have several prints made of various contrasts and send them all the printer.

Prints for publishing do not have to be much bigger than 15 × 12 cm. Never write directly on the back of a photographic print because you may damage the front surface. All photographs must be labeled, so write the information on a peel-off label and put it on the back of the print. Remember to let the ink dry on the labels before stacking the prints so that ink from a label does not smudge the print facing it.

When printing black-and-white photographs in such small sizes, a range of films will provide good results. Just as with colour slide films, in general you get higher quality photographs by using film with a slower speed, but films with a speed of up to 400 ASA will provide good results if they are processed carefully.

COLOUR PRINT FILMS

Remember—do not use colour print film if you intend to publish the photographs. If you have no choice but to use colour print film, then send the negatives to the publication so that they can have a print made by a professional firm.

Colour prints will fade—the bright prints that you store in your files today will fade over time, even faster under tropical conditions. Try leaving a print out in the bright sun for a few days and see what happens.

Exposure

The exposure meters in cameras are set to read correctly using a midgray colour. White reflects a lot of light, black reflects very little, so it is logical to 'zero' the meter on midgray. In many sophisticated cameras, the exposure is calculated by the camera averaging the exposure over the entire field of the viewfinder.

This means that an automatic camera will record gray perfectly, and also take a nice shot of a group of people standing on a lawn with the sun in front of them and a blue sky behind. Once you start taking any other shots, things may not be so easy. If your camera has an adjustable lens and shutter speed, you may want to 'bracket' your exposures—take a shot using the automatic meter settings, an exposure with 1 f-stop more light, and then another with 1 f-stop less light.

This may seem like a waste of film, but in the overall scheme, the cost of film is relatively minor. If your exposures are incorrect, by the time you get the film processed, the experimental plots or other subjects you photographed will not be at the same stage, and you may have to travel long distances to take the photographs again.

All films have a range of contrast that they can handle. In a normal sunlit scene there are very black shadows and very brightly lit areas, with many shades in between. The exposure range between the shadows and sunlit areas might be several f-stops. Most films can't handle such a wide range, so you need to choose which area of the photograph is most important to show detail

An example of such a scene might be farmers harvesting rice in southeast Asia. The sun is bright and hot, so they are all wearing hats with wide brims, but the hats cast deep shadows on the farmers' faces. With normal exposure, their faces would be completely black with no detail. Likewise, if you try to photograph a shrub against the sky, the exposure meter will read the light from the sky and the shrub will appear as a silhouette.

COLOUR SLIDE FILM

Slide films do not have a wide exposure range. They can retain detail over a range of only 3 or 4 f-stops. In addition, they are processed by machines, so there can be no adjustment by the processor. If a slide is overexposed, it has distracting areas of white and an overall thin, washed out appearance. It is usually best to risk underexposure with slides to get some detail in the brightest areas, or highlights, and let the dark areas go black. In this way the colours come out much richer, or fully saturated.

When using slide film it is particularly important to 'bracket' exposures. Film might seem expensive, but it is a lot more expensive to have to return to a site because the photographs were not good.

BLACK-AND-WHITE FILM

Black-and-white film has more exposure latitude than colour slide film—it can cope with a wider range of contrast and hold detail in the lighter and darker areas. It does not need the precision exposure that slide film demands to give an acceptable print. Remember, we are not talking about exhibition quality prints, but rather prints good enough for publication.

COLOUR PRINT FILM

As you should not intentionally use colour print film for publication, we will not mention it except to say that you should expose for a midrange tone at the scene.

Lighting

Try to have the light positioned behind you so that it strikes the front or the side of the subject. Do not try to take arty backlit photographs if you are trying to illustrate something. Watch that you don't get your shadow in the picture.

Light coming from an angle, for example, at sunrise or sunset, can really bring out the texture in a scene or a plant and bring it to life.

If you are forced to photograph against the light or up into the sky, try to use a flash to fill the dark areas and even out the contrast.

THE COLOUR OF LIGHT

Light has a colour, which depends on where it comes from. Midday sunlight is bluish white. Morning light is reddish orange, and at sunset, the light turns very red. Moonlight is blue. The light from a fluorescent strip light is a horrible green, and incandescent light bulbs are warm orange. Street lights are all sorts of colours. If you take a photograph in a laboratory without a flash, everything is usually a sickly green. If the true colour of a specimen is important, you need to use your flash to get good colour balance, or take the photograph outside, using daylight.

Point of view

Photos look most normal when they are taken from head or waist height. If you point the camera straight down to photograph a leaf on the ground or straight up to get the sky and the top of a tree the effect can be a misleading perspective, especially if you are using a wide-angle lens. Remember that the frame on 35 mm film is rectangular, not square, so that you can turn the camera 90 to include more of a tall subject in a picture. This is better than using a radical angle to try to get it all in.

People also look better if they are photographed from normal angles with the camera at their eye height. For instance, if you are taller than your subjects, then to bend down a bit when you are taking people shots. If you are in a market, squat down to get the camera level with the person sitting on the ground don't photograph the top of her head. Try to get subjects to look into the camera—it brings the photograph alive and adds impact.

Composition

One way to discuss how to compose photographs is to talk about how *not* to take them.

HORIZON IN THE MIDDLE

One of the most common faults in photographs is to place the horizon right in across the midline of the frame, with the main subject exactly in the center. This means that the top half of the photo is all sky—and very boring. If the sky is particularly interesting, photograph the sky, if not, leave it out. Concentrate on the subject and make sure it occupies most of the frame. One easy way to do this is to remember to point the camera slightly downwards as you make an exposure.

If you are taking a landscape picture, a good rule to work by is to include about one-third sky and two-thirds subject. This is a generally pleasing ratio.

SUBJECT TOO FAR AWAY

Try to fill the frame of the photograph with subject matter of interest to you. So often we see pictures of people standing so far away that

we can't see their faces in the final photo. Move in close to the subject and fill the viewfinder, but don't get too zealous and starting chopping off the tops of heads. If you have an autofocus camera, be careful not to get so close that the camera cannot focus properly. If you have an SLR, use your telephoto lens to fill the frame. If you do not have a telephoto lens, try the low-tech approach of simply walking closer to the subject.

PEOPLE FALLING OVER

Make sure to hold the camera straight. Check that prominent features in the picture, such as the horizon or a tree, are parallel to the edges of the viewfinder. People should not look as if they are about to fall over, nor the water in a lake as if it is about to run out of the photo.

BACKGROUND

Look what is beyond the main subject of your photograph. Don't let trees or poles stick out of heads, and watch out for other distractions in the background. If you are photographing a single plant in a plot, a background of other plants may lead to a jumbled and confusing photo. Consider removing the plant from the plot and photographing it against a plain background.

If you plan to take photographs of specimens in situ, you may want to carry a big piece of neutral gray material to use as a background. Do not lay specimens on the ground and photograph them while standing above them—the resulting perspective can make people dizzy. Kneel down to photograph them from a more natural angle.

Camera workings

The camera you use will probably have many automatic features, but a basic understanding of how the camera controls light will help you take better pictures.

Both shutter speed and aperture govern the amount of light that hits the surface of the film. Shutter speed controls how long the mechanism that allows light into the camera is open. The aperture is the opening through which the light passes. The aperture is essentially a hole that can vary in size.

You have no control over either of these variables with most small cameras—the exposure is calculated and controlled by the camera. Most SLRs, although also automatic, give you more freedom. Either you set the shutter speed and the camera sets the aperture, or you set the aperture and the camera sets the shutter speed. With most automatic SLRs, you can override the automatic mode and set everything yourself. With a manual SLR you must set the aperture and speed.

SHUTTER SPEED

When you are holding a camera in your hands (not using a tripod), never use a shutter speed slower than 1/30 of a second, or the photograph will almost certainly be blurry because you will move the camera. Use a tripod at these slow speeds. Try to use shutter speeds of 1/125 and faster when hand holding the camera.

Fast shutter speeds are used for stopping action. but as plants don't grow that fast, you may not need to use them unless there is a lot of light.

When you are taking a picture, squeeze the shutter release slowly—don't jab at it.

APERTURE

Apertures (or f-stops) are confusing because the bigger the number, the smaller the hole in the diaphragm inside the lens (which controls the amount of light entering the camera). Depth of field is the zone that will be in focus in your photograph. The smaller the aperture (bigger numbers such as f16 or f22), the greater the depth of field.

You can use the aperture to affect your photograph. If you want as much as possible in focus, then use a small aperture. This will reduce the amount of light, so you must compensate by using a slow shutter speed.

If you want a specific section of the picture to be in focus, for example, a plant specimen in the foreground, then use a wide aperture and a faster shutter speed. Telephoto lenses have a narrow depth of field, and wide-angle lenses have a greater depth of field.

In general

When you are out in the field, it is usually good practice to take several photographs of the same subject from a number of different angles or viewpoints. This increases your chances of getting that perfect shot.

If you have different lenses, use them to add some variety to your photographs. For example, use a wide-angle lens to set the scene, and then a telephoto to zero in on particular details.

Publishing ethics

Purpose

This unit will help training participants to:

- understand the ethics of scientific publishing
- conform to the international recognized conventions surrounding copyright and intellectual property

YOU SHOULD ALWAYS keep in mind the way things are done and the strict code of ethics that exists in the field of scientific publishing.

Double publishing and multiple submission

Double publishing is when the same body of data is used to produce two papers that are published in two different places. This is strictly forbidden in scientific publishing circles. In addition, never submit the same article to several journals at the same time. If and when you are found out it could be very embarrassing for you.

Many international journals are becoming ruthless in their treatment of what they consider to be dishonest authors. Double publishing, and multiple submission, are looked upon as cheating. Most journals make it a condition when they accept a paper for consideration that it is not being considered for publication anywhere else. Submit one paper to one journal at a time. Never try to make two different papers out of the same block of data. The exception to this rule is

writing for a general audience in a popular publication. After your research paper has been published in a scientific journal, you may then rewrite the material for a lay audience and publish it in the media. Not only is this ethical, it is to be encouraged. It is often only in this way that the public knows what scientists are doing. Even funding of project proposals can come about through popular writeups of research.

If an article has already been published in your own language, you should not expect to translate it, send it off to an English-language journal and publish it there also. This may be seen as unethical. If you intend to do this, you should tell the editor of the English-language journal what you have done as you submit the paper. If your research has already been published in another language then you might still be able to translate and adapt the material for another journal, but it is best to check with the journal first. Remember also that you will probably need the original journal's permission to use the material in that way.

If an article or a body of research has been published already as a preliminary communication or read at a major symposium or published in a proceedings, this should be pointed out to the editor. Publication like this may not mean that your paper is automatically rejected, but telling the editor is common courtesy and will protect you from later misunderstanding.

You should also contact the conference organizers if you are doing this, if they hold the copyright to published proceedings.

Authorship

Another consideration is authorship. Who holds the rights to the data? Who did the research? Are you entitled to write up and publish the work? Whose names should be on the paper? If you did some research in another country, perhaps for an MSc or a PhD, you are entitled to use that material, but you should always clear it with the supervising body of the university or institute in which you worked.

If you intend to name other people as co-authors you must check with them to ensure that they have no objections.

The names at the top of the paper should be those of the scientists who did the research, and nobody else. Some journals allow special mentions like 'with the technical assistance of . . .' on the title page, but these are rare. Journals do not want directors' names first, or anywhere at all, if they did nothing in the experiments or in helping to write the paper. Do not load up your paper with a long string of names.

Authorship is a dangerous area. Journal managers are just as sensitive about disputed authorship and allegations of stolen results as they are about double publishing. so be very careful that every author you mention fully agrees with the publication of the paper in the form that you present it.

The following guidelines for authorship are suggested:

- The first author should be the one who did most of the work and wrote most of the paper.
- Second should come the person who supervised the activity of the first, as well as planning the study and helping to write the paper, or, alternatively, the person who did a smaller part of the work.
- Next: any other workers listed in decreasing order of contribution.

Copyright

People who write anything, however long or short, automatically possess, in most countries, certain rights to their work. This is based on the idea that if you have spent your time writing something, then if someone else uses it you should expect to be rewarded for that use. You wrote it so you should be able to choose and control where and how it is published. This is known as copyright. You 'hold the copyright' to your work

If a written work is to be published, the authors will usually transfer some or all of these rights, by formal agreement, to the publisher. Two of these rights are the right to make copies of the work and the right to distribute these copies. This is international practice. Most journals will publish a copyright notice where they claim the copyright. This is made up of the copyright symbol, ©, sometimes the word 'copyright', the year of publication, and the name of the copyright holder. Sometimes the phrase 'all rights reserved' also appears.

Contributors to a journal possess exactly the same rights as authors of books. When an article is accepted by an international journal, the author is usually asked to sign a formal transfer of rights to the publisher. The publisher will then hold the copyright.

Permission to reproduce material

If you want to include in your publication a figure or a table or other matter from a published work that is under copyright, you must get permission from the copyright holder. It is your responsibility as an author to do this.

This is not difficult. You write to the publisher giving exact details of what you want to reproduce and where you want to print it. Most presses will grant all reasonable requests, at no charge, subject to the agreement of the author. At the same time, write to the author and ask for permission. When you receive that, again usually automatically, you send copies of both permissions with your article to your publisher or journal editor.

Take care to include in the legend of the copied item a full credit to the source, including author, publication, date, and publisher. A typical credit line in a figure legend would read as follows:

reproduced with permission from CSIRO Australia, Jones AB. Aust J Bot 1985;53:121–5

Guarantee of material

In signing a publication contract or submitting a paper to a journal, authors guarantee that

- the work is original
- the author owns it
- no part of it has been published previously
- no other agreement to publish all or part of it is outstanding

If you have published a significant part of the material elsewhere, you must obtain written permission to reprint the material from the copyright holder and send a copy to the publisher. You must also mention this matter of copyright in your paper.

Symposium and journal publishing

If you read a paper at a conference, the proceedings of that meeting may be published at a later date. If you submit the same paper to a journal, you are in danger of committing two offences: double publishing and breaching copyright.

If the journal article is published first, you will need that publisher's permission to print the paper in the conference proceedings, even though you read the paper at the conference before sending it to the journal. If the paper is to be published by a journal and the conference proceedings are already published, you will need the permission of the conference publishers to print the paper in the journal. Either way, you will be publishing the same research results twice; that makes journal editors nervous.

How do you resolve this problem? Simple. Do not do it. Withdraw the article from the conference proceedings before you submit it to the journal, or do not submit it to the journal. Do not wait to see if the journal accepts it before you withdraw it.

Many papers read at conferences are preliminary, or parts of a larger work. In this case, you may submit the whole work later to a journal, but again, you may need copyright permission for certain parts of it. You should tell the journal editor, from the very start, what you are doing.

The issue of copyright is complicated. This is only a brief summary. Most publishers are strict about copyright matters. You should be certain of your position before you commit yourself to publishing. You are advised to seek further information from relevant books in the list of recommended reading or from the journal editors themselves.

Recommended reading

BOOKS RECOMMENDED FOR HELP in writing science papers are listed here alphabetically by title.

The careful writer: a modern guide to English usage. Theodore M. Bernstein. New York: Atheneum; 1986. ISBN 0-689-70555-7.

CBE style manual: a guide for authors, editors, and publishers in the biological sciences. 5th ed. CBE Style Manual Committee. Bethesda, MD: Council of Biology Editors; 1983. ISBN 0-914340-04-2.

The Chicago manual of style. 14th ed. Chicago: University of Chicago Press; 1993. ISBN 0-226-10389-7 hardback.

Communicating in science: writing and speaking. V Booth. Cambridge: Cambridge University Press; 1984.

The complete plain words. E Gower; rev by Sidney Greenbaum and Janet Whitcut. Boston: Godine; 1990.

A dictionary of modern English usage. 2nd ed. HW Fowler; rev by E Gower. Oxford: Oxford University Press; 1965. ISBN 0-19-869115-7 hardback; 0-19-281389-7 paperback.

Dictionary of troublesome words. Bill Bryson. Harmondsworth. England: Penguin Books; 1984. ISBN 0-14-051130-X

Editing and publication: a training manual. Ian Montagnes. Manila: International Rice Research Institute and Ottawa: International Development Research Centre; 1991. ISBN 971-22-0008-6.

Effective writing: improving scientific, technical and business communication. 2nd ed. Christopher Turk and John Kirkman. London: E & FN Spon; 1989. ISBN 0-419-14660-1.

The elements of style. 3rd ed. William Strunk Jr and EB White. New York: Macmillan; 1979. ISBN 0-02-418230-3 hardback; 0-02-418220-6 paperback.

Envisioning information. Edward R Tufte. Cheshire, CT: Graphics Press; 1990.

The fine art of technical writing. Carol Perry. Hillsboro, OR: Blue Heron; 1991. ISBN 0-936085-24-X

A guide to scientific writing. D Lindsay. Melbourne: Longman; 1984.

How to write and publish a scientific paper. 3rd ed. Robert A Day. Cambridge: Cambridge University Press; 1988. ISBN 0-89495-006-1.

A manual for writers of term papers, theses and dissertations. 5th ed. Kate L Turabian. Chicago: University of Chicago Press; 1987. ISBN 0-226-8162409 hardback; 0-226-81625-7 paperback

- The new shorter Oxford English dictionary on historical principles*. 1993. Oxford: Oxford University Press, Clarendon Press.
- The New York Public Library writer's guide to style and usage*. New York: HarperCollins; 1994. ISBN 0-06-270064-2.
- Oxford dictionary of current idiomatic English*. Vol 1: *Verbs with prepositions and particles*. AP Cowie and R Mackin. Oxford: Oxford University Press; 1975.
- Oxford dictionary of current idiomatic English*. Vol 2: *Phrase, clause and sentence idioms*. AP Cowie and R Mackin. Oxford: Oxford University Press; 1983.
- The Oxford writers' dictionary*. Oxford: Oxford University Press; 1990. ISBN 0-19-282669-7.
- Presentation of data in science*. L Reynolds and D Simmonds. The Hague: Martinus Nijhoff; 1982.
- Publications handbook and style manual*. Madison, Wisconsin, USA: American Society of Agronomy, Crop Science Society of America, Soil Science Society of America; 1988.
- Scientific style and format: the CBE manual for authors, editors, and publishers*. 6th ed. CBE Style Manual Committee. Cambridge: Cambridge University Press; 1994. ISBN 0-521-47154-0.
- The scientist's handbook for writing papers and dissertations*. AM Wilkinson. Englewood Cliffs, NJ: Prentice-Hall; 1991.
- Style: toward clarity and grace*. JM Williams. Chicago: University of Chicago Press; 1990.
- The visual display of quantitative information*. Edward R Tufte. Cheshire, CT: Graphics Press; 1983.
- Writing research papers: an easy guide for non-English speakers*. Paul Stapleton. Canberra: Australian Centre for International Agricultural Research; 1987. ISBN 094 9511 555.
- Writing successfully in science*. Maeve O'Connor. London: HarperCollins Academic; 1991. ISBN 0-04-445805-3 hardback; 0-04-445806-1 paperback.

Index

- abbreviations 50-54
abstract 18
 definitive 18
 descriptive 18
 proposal 97
abstract nouns 34
acknowledgements 18-19
acronyms 53
annual reports 5, 7
aperture, camera 117-18
audiences 6-7, 21, 103-4
author-date system see
 name-year system
authors and authorship
 17, 121-22
- bar graphs 79-80
book chapters 5, 7
budget, proposal 99
buzz words 33
- cameras
 exposure calculations
 113
 types 109-10
 workings 117-18
citation-sequence system
 64-65
communication avenues
 3
communications
 extension 3-4
 research 3-4, 6
composition in
 photography 116-17
conference papers 5, 7
conference proceedings
 124
contractions 52-53
- copyright 122-24
correspondence 45
country codes 51, 58-59
currency codes 51, 58-59
- dates 49-50
Discussion section 16,
 23-24
diskette, submitting
 manuscript on 30
dissertation 5
documentaries 103
double negatives 33
double publishing
 120-121
- editorials 103
English, good usage
 31-46
errors of meaning and
 form 35-36
ethics in publishing
 120-24
exposure in photography
 113-15
- feature articles 103, 106-7
'females' and related
 terms 43-44
figures see illustrations
figures (numbers) 28-29
film, photographic
 111-13, 114-15
first draft 25-26
flash photography 111
flow charts 79, 82
- gender and gender-
 neutral terms 42-43
- graphs 83-85
gratuitous modifiers 43
- headlines 104-5
'hedging' 40
histograms 82
- illustrations 78-87
 characteristics 79
 types 79
IMRAD form 11-19, 21
instructions to authors
 10, 49, 59, 61, 63
Introduction section
 13-14
- jargon 36
journal 4
 choice of 8-9
- language, direct 32-33
lenses, camera 110-11,
 118-19
lighting in photography
 115
line drawings 79, 83,
 85-86
line graphs 79, 82
lists 39
- magazine articles 103,
 106-7
'man' forms 40-41
manuscript
 final 29-30
 following up 30
 keeping duplicate 30
 mailing 30
maps 79, 83-84

- Materials and methods section 14-15, 24
- mathematical symbols and equations 61-62
- media 101-8
- multiple submissions 120-21
- names and titles, non-sexist 44-45
- name-year system 63-65
- newsletters 6
- news stories 103, 105-6
- nomenclature 57, 59
- non-sexist language 40-46
- noun clusters 34-35
- nouns from verbs 34
- numbered alphabetical system 64
- numbers 47-49
inclusive 49
words or figures 47-48
- opinion pieces 103, 106-7
- oral presentation 88-90
- outline 22
- personification 43
- photographs 10, 79, 83
- photography 109-19
- pictorial graphs 79, 80
- pie chart 79, 81-82
- popular writing 101-8
- posters 91-95
layout plan 95
- major elements 92-93
preparing 93-94
- press releases 102
- project proposals 6-7
- pronouns
personal 39
in unbiased language 41-42
- proposal writing 96-100
- qualifying, or hedging 40
- radio 103
- references 19, 23, 63-72
to book 70
to chapter in book 70
checking 28
journal article 70
to personal communications 71
to reports 71
- report writing 96, 99-100
- research papers 7
- Results section 15, 24
- review papers 5, 7
- salutation 45
- scanned images 86-87
- scientific names 59-61
- scientific paper
characteristics 12
parts 13-19
- second draft 26
- sentence structure 36-38
- sentences, long 36-37
- sexist and alternative terms 45-46
- shutter speed 117-18
- simple and direct language 32-33
- SI units 50-57
- spelling 33, 61
- style
journal 10
scientific 31-46
- symbols 54
- symposium papers, publishing 124
- tables 48, 73-77 handling 28-29
parts of a table 74
- television 103
- tense, verb 38
- text citations 64-66
theses 5, 7
- third draft 28
- titles 16-17
proposal 97
working 21
- unbiased language 41-46
- units, SI 50-57
- verbosity 32-33
- verbs and verb forms 38-39
'man' as verb 40
voice 38-39
- working title 21
- writing, planning 20-23