Scientific Writing for Agricultural Research Scientists

A Training Resource Manual

Edited by
Anthony Youdeowei
Paul Stapleton
Rodger Obubo

About CTA

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Its mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries. It provides access to information and knowledge, facilitates policy dialogue and strengthens the capacity of agricultural and rural development institutions and communities. CTA operates under the framework of the Cotonou Agreement and is funded by the EU. For more information on CTA, visit www.cta.int or contact:

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> *Effective communication is an essential part of the scientific endeavour*

Foreword

I am pleased to note that CTA continues to play an important role in addressing the subject of scientific writing in agricultural research.

Agricultural research in African, Caribbean and Pacific (ACP) countries has been characterised by poor communication and limited use of its results by beneficiaries. This could be attributed partly to the lack of formal training programmes in scientific writing and editing. As a result, although a lot is invested in research, very little is made available to users in the form of either peer-reviewed publications or extension materials. Generally, after scientists have successfully completed their research, they should communicate and share their results with colleagues and the broader scientific community. To be successful, scientists must develop the culture of writing and communication, so that they can promote the effective dissemination and use of their research outputs.

Effective communication is an essential part of the scientific endeavour. Scientists and development workers have several motives for writing research papers for publication in technical and general journals. The original initiative of AfricaRice (formerly WARDA) and CTA to strengthen scientific writing in agricultural research has been very well received. Advances in internet and other communication technologies have necessitated a revision of the original (1995) publication to reflect new developments, including as e-publishing and online journals. We believe this revision will make a useful contribution to the efforts of agricultural researchers, publishers and the scientific community at large.

This revised edition addresses practical issues that agricultural researchers face on a daily basis. It aims to give valuable advice and direction to agricultural scientists in the ACP countries, who often grapple with how to write an effective paper and get it published. This book also addresses the challenge of communicating with non-scientific audiences and informing them about the benefits of investments in agricultural research.

I would like to thank the contributors who dedicated their time and energy to revising and, in some cases, rewriting the various chapters in this publication. I also extend my deep appreciation to past trainees on CTA's scientific writing courses, whose questions and comments provided useful feedback and inspiration to the authors when updating the manual.

Michael Hailu
Director, CTA

Preface to the new edition

In preparing this new edition of *Scientific Writing for Agricultural Research Scientists*, we have considered and reflected on the concept of the manual in terms of achieving two major objectives. First, the book aims to serve as a guide for agricultural research scientists and other practitioners in writing research papers for publication in scientific journals and in preparing research reports. Secondly, it serves as a training resource manual for resource persons who are planning training courses in scientific writing.

The number of chapters in the original edition has been increased in this new edition, with three new chapters on:

– reporting statistical results in research papers;
– communicating science to non-scientific audiences;
– electronic publishing.

In addition, all the original chapters have been rewritten to reflect current developments in the patterns of communicating scientific information and to make the content more complete and easily comprehensible.

At the end of some chapters, where appropriate, exercises are presented to facilitate greater understanding of the chapter topic. The annex to this new edition presents guidelines on a framework for planning and managing training courses in scientific writing, as well as practical, hands-on exercises that can serve as a guide for preparing practical exercises in group training courses. These exercises can be adapted to suit the particular circumstances in which a training course is being conducted.

It is our hope and belief that this new edition achieves the two objectives stated above. CTA and the editors are grateful to all the authors who have contributed to this new edition. We expect that this book will be useful in promoting effective communication of agricultural research results and in supporting group training courses in scientific writing for agricultural research scientists.

Anthony Youdeowei

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Acknowledgement
of the original edition

Introduction to the original edition

The need for training targeted at African agricultural research scientists on the procedures and techniques for writing and publishing the results of their research has been identified by a variety of institutions, organisations and agricultural research and development networks throughout the region.

Early in 1990, the West Africa Rice Development Association (WARDA) and the West African Farming Systems Research Network (WAFRSN), 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 organise 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 identified, details of the 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 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;
— create a community of agricultural researchers who regularly communicate with one another and thereby minimise 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.

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

Paul Stapleton

Avenues for the communication of science

1

1.1
Introduction

Science and scientific research are essential components in the process of development. Continued agricultural research is critical to the progress of countries that are agriculturally based. Disseminating the results of such research so that they can have a clear impact is also essential. However, a problem in many countries is that information is not easy to obtain – research results are ineffective unless they are put to some use.

Most scientific communication today is still made in written form – even though websites such as YouTube feature hundreds of thousands of science-based films. Effective communication is based on the people involved in the system, of whom none is more important than the interpreter or editor, who is able to see what sort of information should go where, how, and to the best effect. Most scientists are not expert writers; they are professional scientists. But with a little effort, all scientists can go some way towards adapting their material to suit a specific audience. The most common example is the way that scientists can generate a visual presentation to a meeting from a research paper that they have written. This chapter is concerned with avenues of communication within the research field.

1.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:
– recognise the different avenues of communication within scientific research;
– choose the avenue most suitable for the audience you are addressing;
– be aware that you must adjust your writing style to suit the needs of your audience.

1.3
Avenues of communication within the research field

What avenues of communication do scientists have open to them in order to deliver information? For research communication, these include:

– research journals;
– research reviews;
– short communications;
– conference papers and posters;
– theses;
– books and book chapters;
– annual reports;
– working papers;
– newsletters;
– project proposals and reports;
– websites;
– blogs and discussion groups.

Each of these has specific uses in certain situations.

1.3.1 Research journals

The purpose of a research journal is to publish scientific papers that communicate new and original information to other scientists. Every journal has its own definition, but almost all of them centre on the phrase 'original research'. That means research that has not been done or published before. The research paper takes a hypothesis and tests it by experimental methods in order to reach conclusions. Research journals are the most common organ of communication in science.

There are two types of reader of research papers. One is the expert in the field, who will want to read all of the paper to obtain all the information from it. But, more commonly, there are more casual readers, who will be interested in the results only as a background to their own work.

In their initial form, research journals may be widely disseminated, as paper publications and online; in their secondary form, where titles, or titles and abstracts, are published by the secondary publishing industry, they are exposed worldwide.

Assessment of the number of papers a scientist has published as a measure of their success and as a basis for promotion is very common. In the United States and some other countries it has gone even further – if a scientist does not produce papers from their research, they cannot obtain funding for their research, and they may lose their job.

The findings in most international research articles are believed to be fact because they are known to have been refereed or judged by experts in the field before they can be accepted for publication. Because of the high standards usually required of articles in overseas journals, it is often difficult to have a locally based paper accepted.

The whole basis of peer-reviewed publication is to make available work that is worth publishing. Scientists should not be rewarded for writing a paper; they should be rewarded for performing work of a sufficient standard that they can write a paper based on it that is acceptable to a critically minded audience. The system becomes meaningless as a measure of merit and promotion if any and all papers are accepted and published without critical assessment.

Publishing research results internationally will stimulate debate and encourage further work on the subject. It will produce information exchange, advance knowledge, and open up new opportunities for research. To achieve this, a paper should be directed at a specific journal read by a suitable audience of interested researchers.

1.3.2 Research reviews

The review is a special type of scientific article that, in many ways, is like an extended version of the discussion section of a research paper. An essential feature of a review is that the reader is led to the frontiers of science in the area covered.

The review summarises all aspects of a particular field; it also develops logical arguments until they end in new hypotheses, and speculations on how they may be tested. It leads to new areas of research, which must be testable and must be supported by facts – but the review is not a catalogue of facts. Rather, it interprets existing facts and theories within a particular field, often with the intention of explaining that field to other workers in closely allied fields of investigation.

1.3.3 Short communications

These are preliminary results of a project, perhaps one season's results, or results that are not of major significance but are nevertheless interesting. The exact nature of these communications will vary with the target publication.

1.3.4 Conference papers and posters

Conferences offer scientists an opportunity to present results of research that is still at a preliminary stage, but that contains interesting developments. Because time is limited during a conference session, papers that are presented orally at conferences are necessarily short. They are usually confined to a brief presentation of the methods and, more importantly, the results, which may be preliminary, and several clearly stated points brought out in the discussion. Speculation can be introduced; interpretation is by far the most important area to have impact. The version presented for publication can be more thorough. Conference organisers accept or reject papers based on an abstract that the author submits.

Reviewers develop a list of papers and allocate them to different sections of the conference. Usually there are many more papers submitted than can be read, so organisers offers authors of less significant, but still interesting, papers the chance to present a piece of work as a poster. Authors have wall space, usually about 1 × 1.5 metres, on which to present their findings, and are given an opportunity to discuss their work with passing scientists.

1.3.5 Theses

The thesis is written evidence of sustained research, testing a particular hypothesis in a novel area, done over a considerable period, usually 5 or 6 years. The overriding characteristic of a thesis is its length. It generally contains an extensive review of the literature, as well as the results of a number of experiments, all aimed at testing a unifying hypothesis. Some of the material may already have been published in a series of research papers during the course of the research.

1.3.6 Books and book chapters

The book chapter is a synthesis of knowledge and information about a particular subject. It rarely has a fundamental hypothesis. It is more likely to form one part of an overall contents list that, taken together, exhaustively describes a clearly defined aspect of one field of science.

1.3.7 Annual reports

Annual reports contain straightforward descriptions of work that has been done during a year or 12-month period. The intention is not so much to prove a hypothesis, rather to describe activities, justify budget expenditure in terms of research undertaken, and demonstrate impact to attract more funding. The traditional approach to annual reports was to describe all activities of all the programmes of an institution. This approach is useful to give an overall idea of the institution's work, and to form a historical record. However, such reports can be long and very detailed. There is a tendency more recently for annual reports to concentrate on one aspect of the institution's work, or to select the areas of work that have had most impact.

1.3.8 Working papers

A working paper or technical report may be a preliminary report of a piece of research that is interesting, but suitable or intended for peer-reviewed publication. In many cases, a working paper can be developed later, with the addition of more material, into a scientific paper. Often authors may release working papers to share ideas about a topic or to elicit feedback before submitting to a peer-reviewed conference or academic journal.

1.3.9 Newsletters

The purpose of a newsletter is to communicate quickly facts that are of interest to its readers. Thus the content of any contribution is basically factual, with little emphasis on justification or methodology. Usually having a more general readership, newsletters should never be regarded a substitute for the true publication of research results.

1.3.10 Project proposals and reports

A project proposal represents the justification for a programme of work, with the aim of producing measurable outputs that will demonstrably reach a clearly defined objective. Like a research paper, it starts out with a hypothesis that has led to a proposed course of action and a programme of research designed to test the concept.

1.3.11 Websites

Most research institutions now have a website, where they present their most up-to-date or significant results, describe the institution and its programmes of research, and list its staff. Often there is a list of publications, with some sites offering the possibility of downloading copies of institutional publications, working papers, etc.

Websites have a potentially huge audience with different levels of expertise, and so offer scientists an opportunity to publicise the results and impact of their research to groups of people different from the usual scientists.

1.3.12 Blogs and discussion groups

A blog (a contraction of the term 'web log') is a type of website, usually maintained by an individual, with regular entries of commentary, descriptions of events, or other material such as graphics or video. Blogs are personal, representing the views of the writer, and so offer scientists a chance to put forward their own ideas, free of the constraints of the institution they are working within.

Discussion groups are electronic meeting places, where groups of people with a common interest can share their views in a continuing discussion.

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The technical content of any publication is crucial to the understanding of its intended audience

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1.4
Audiences

Many groups of people are concerned with agricultural research in one way or another, but have very different needs, and receive information in different way. The most common audience groups include:

– researchers within a specific field of research;
– researchers with a peripheral interest in a field of research;
– research managers;
– extension agents;
– university teachers;
– students;
– policy-makers;
– donors;
– governmental research coordinating committees;
– technicians;
– commercial interests;
– farmers.

1.5
The intent
of a research
communication

Different research communications have different intents. They take the same basic information and modify it so that different audiences, with various levels of scientific understanding, can understand it (see Table 1.1).

The technical content of any publication is crucial to the understanding of its intended audience. If the person reading the material cannot understand it, then the whole point of the work is lost. This will obviously have tremendous implications for the impact of the work and its benefit to the writer.

1.6
Exercise –
Assessing
publication
types

List the different types of publication you have to write.

– Who are you writing for?
– What level of scientific content should each type of publication have?
– Draw up your responses into a table for later use.

Table 1.1
Types of research communication,
their audience and technical content

Avenue	Audience	Technical content (1, high; 7, low)
Research papers	Researchers within and outside the discipline, university students and lecturers, senior extension workers, research managers	1
Book chapters		
Technical	As for research papers	2
General	Technicians, students, extension workers	4–5
Research reviews	Researchers outside a discipline, university students and lecturers, extension workers, commercial interests	2–4
Short communications	As for research papers	1–3
Theses	Researchers within a discipline, university students and lecturers	1
Conference paper	Researchers within and outside a field, university students and lecturers, research managers	2–3
Annual reports		
Highlights	Donors, policy-makers, government committees, extension agents, institute directors	3–4
Main text	Researchers within and outside a field, university students and lecturers, research managers	1
Newsletters	Researchers within and outside a field, students and lecturers, extension agents, policy-makers, expert farmers	5–6
Project proposals	Donors, policy-makers, research managers, institute directors	2
Websites		
Popular	General public	7
Professional	Technical audiences	3–7

Paul Stapleton

Choosing a journal in which to publish

2

2.1
Introduction

So much research is published today that there is a whole science based on impact assessment and citation analysis. Information analysts keep careful note of which papers are being cited and who is writing them. Careers depend on it, as do the success and prestige of journals, and the reputations of university departments and research institutions. So you need to target your writing and publishing to maximise the chances of someone reading it and making use of your findings.

When you have decided that you should be writing a paper, and that you have a paper to write, you must then start thinking about your audience. From the very start, you should aim at getting the paper seen by the right audience. To do this, you should direct your paper at a specific journal that is read by the people you want to contact. Before you start planning your article, you need to decide in which journal you want to publish. The choice of journal will influence the format and style of your article, and how you prepare it. For example, many of the biggest journals these days accept only online submissions.

2.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– evaluate a journal's publishing policy, scope and content;
– define the special requirements for producing an article for publication;
– choose the best journal in which to publish your work.

2.3
Choosing a journal

Most journals today receive many more papers than they can possibly publish. The best journals have a very high standard for papers they accept, and a very high rejection rate. Ask yourself if your paper is really good enough to send to the very best journal. It may be better that you select a less important journal, to stand a better chance of acceptance. There are a number of factors to consider. Study published copies of different journals and look at their websites. Many journals have a lot of information available to help you understand their requirements and to prepare a paper for submission.

2.3.1 What is the scientific level of the journal?

Look at past issues of the journal and ask yourself the question: is my work as good as, or better than, the material the journal is publishing? Who is the editor? Who is on the editorial board? Which authors publish in the journal? Does the journal have an international audience? Does the journal want complete research projects, or will it accept accounts of work in progress and preliminary papers?

2.3.2 What are the aims and scope of the journal?

These are often printed on the inside cover of the journal and published on the journal's website. Read their "Aims and scope" statements to find out exactly which area of your discipline the journal is interested in. It is no use sending a research paper to a journal that only publishes reviews, and it is no use sending a theoretical paper to a journal that publishes only practical research. For example, *Agronomy Journal* has the following text on its website (www.agronomy.org/publications/aj/about):

About *Agronomy Journal*

Articles relating to original research in soil–plant relationships; crop science; soil science; biometry; crop, soil, pasture, and range management; crop, forage, and pasture production and utilization; turfgrass; agroclimatology; agronomic modeling; statistics; production agriculture; and computer software are published in *Agronomy Journal* subsequent to review and approval by the editorial board. Articles should make a significant contribution to the advancement of knowledge or toward a better understanding of existing agronomic concepts. The study reported must be of potential interest to a significant number of scientists and, if specific to a local situation, must be relevant to a wide body of knowledge in agronomy. Additional details on requirements for articles are published in *Agronomy Journal* each year.

2.3.3 How often is the journal published?

Scientific publishing is usually a slow process, and a journal that is published twice a year will have a much longer potential publication time than one that appears once every 2 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, then you can send it to a fast-publication journal, but if rapid publication is not essential, then the editors of such a journal will probably reject your paper immediately, just because of that, not because of its scientific quality.

2.3.4 What types of article does the journal publish?

Will yours fit this pattern? Many journals have a specific format for the articles they publish, for example, the IMRAD format (Introduction, Materials, Results and Discussion; see Chapter 3). If your article does not fit this pattern, the paper may be rejected. If your paper is going to be 20 printed pages long and the journal only publishes papers up to five pages, this will mean that yours will be rejected – not because of the scientific content, but just because of the format of the paper.

2.3.5 Are there any conditions to submitting to the journal?

For some journals, one of the authors must be a member of the society that publishes the journal. Sometimes there are certain types of statistical analysis that must be used, and the experiments must have been repeated a certain number of times. Many journals have page charges, where you have to pay the journal to publish your paper. The charges are based on the number of pages in the final published paper. These charges can be extremely high. Page charges are widely used throughout the scientific publishing community, and are widely accepted. For example, most US government agencies recognise the payment of page charges as a legitimate part of the cost of performing research and development work under government contracts. You should look for these conditions carefully in the journal, and consider whether you have enough money in your budget. However, some journals will not charge authors from certain countries.

2.4
Open-access journals

Most research journals are published by an academic publisher or scholarly society. These have to make money, so people have to buy the journal, or pay for access to the papers online. From 2001, the concept of open access via the internet has become more common (see, for example, www.soros.org/openaccess and http://en.wikipedia.org/wiki/Open_access_journal). Open-access journals are available to anyone who has access to the internet. Almost all provide information free of charge; some are subsidised, and some require payment on behalf of the author. Open access is the subject of much discussion, with disagreement about the concept of open access, the value of the information published, and the worth of the journal. That being said, there are many hundreds if not thousands of open-access journals available on the web, some with strict per-review procedures and very high citation indices. Much wider discussion of open access is available on the web; see also Chapter 16.

2.5
How scientists are evaluated through the papers they publish

Publications are an important output of scientific research. A good publications record, especially authorship of research papers in peer-reviewed journals, is an indicator of your success as a scientist, and a major part of how scientists and academics are evaluated for employment and promotion. Donor agencies will also look at your publications record if you submit grant proposals to them.

Journals that use the peer-review system are generally regarded as being of better quality than those that do not. Obviously, it is more difficult to get your paper accepted by them, but remember that the entire process of peer review can be considered positively as providing training in more effective writing and publishing of your research.

Journal ranking is widely used to evaluate impact and quality. Journal rankings show the place of a journal within its field, the difficulty of being published in that journal, and the prestige associated with it.

2.5.1 The impact factor concept

Nowadays, the importance of journals is ranked by their impact factor, which is a measure of the frequency with which an article in a journal has been cited in a given period. Journals with a higher impact factor are considered to be of higher rank and more prestigious than those with a lower score.

The impact factor for a journal is calculated based on a 3-year period, and can be considered to be the average number of times published papers are cited up to 2 years after publication. For example, the impact factor for a journal for the year 2011 would be calculated as follows:

Impact factor 2011 for *Journal X*:

A = the number of times articles published in 2009–10 were cited in indexed journals during 2011

B = the total number of articles, reviews, proceedings and notes published in 2009–10

Impact factor 2011 = A/B

Note that the impact factor 2011 will actually be published in 2012, because it cannot be calculated until all the 2011 publications have been received.

Information on the impact factor can viewed on the home pages of many reputable journals, or from the *Journal Citation Reports* (http://thomsonreuters.com/ products_services/science/science_products/a-z/journal_citation_reports/), published annually as part of the Science Citation Index. Growing competition for research funding and academic positions has led to the increasing use of bibliometric parameters to evaluate careers by number and quality of publications and the impact factor of the journals they appeared in.

Just about all journals with measurable impact factors are peer reviewed. Peer review is criticised as an imperfect system, and indeed it has some problems. However, it is the best system that we have available at the moment, therefore we have to make the best of it. Even the Public Library of Science (www.plos.org), a series of journals published on the web under the Creative Commons system of copyright, uses peer review.

2.5.2 Citation analysis

Citation analysis is a method of bibliographic measurement that highlights the difference between producing a lot of average research papers, and fewer good papers. This is an objective way of measuring the quality or impact of a paper by charting how many times it is cited by other researchers. The logic is that the better a paper is, the more people will cite it, and this has been confirmed as a valid measure of research quality or impact by many researchers. So your publishing objective should be to publish not only good quality papers, but good quality papers that people will want to cite in good quality journals.

2.6
Resources

This is a complex and fast-moving field, and this chapter merely introduces the concepts. Interested readers can find up-to-date information online by searching for the following terms:

– bibliometrics
– citation analysis
– CiteSeer
– Creative Commons
– eigenfactor
– Eugene Garfield
– Google Scholar
– impact factor
– Institute for Scientific Information
– journal ranking
– Public Library of Science
– scientometrics
– SCImago Journal Rank
– Thomson Reuters

2.6.1 Useful websites

Citation index
– www.thomsonscientific.com/cgi-bin/jrnlst/jloptions.cgi?PC=K

Instructions for authors
– http://www.elsevier.com/wps/find/authorsview.authors/landing_main http://authorservices.wiley.com/
– http://journals.cambridge.org/action/stream?pageId=3608

Choosing a journal
– http://journalauthors.tandf.co.uk/preparation/choosing.asp
– http://libraryguides.griffith.edu.au/content.php?pid=220206&sid=2249695

Open access
– www.earlham.edu/~peters/fos/overview.htm
– http://oad.simmons.edu/oadwiki/Main_Page

**2.7
Exercise –
Assessing journals'
requirements**

If there is a good internet connection, search for the websites of well known journals in your field and study the Instructions to Authors and other information.

– Download pdfs of useful information for later study.
– Find an open-access journal in your subject area and study the papers available.
– Do you feel it would be worthwhile publishing in that journal?

"From the very start,
you should aim at
getting the paper seen
by the right audience"

Paul Stapleton

The IMRAD format for presenting research papers

3

3.1
Introduction

Breaking a research paper into the sections Introduction, Materials, Results and Discussion (IMRAD) is a well established approach to writing and publishing scientific research. It has become the main pattern for research articles in many disciplines. This classical structure does not fit some disciplines, but it is a useful and systematic way in which to approach your writing.

3.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– define the IMRAD format;
– recognise what belongs in each section of a research paper.

3.3
The pattern of a research article

Most types of research article follow a classical pattern, answering a logical series of questions:

Introduction	what led to the work and what are the objectives?
Materials	what was used?
Methods	what was done?
Results	what happened?
Discussion	what does it mean?
Conclusions	what are the implications of the results?
Acknowledgements	who helped?
References	who is referred to in the text?

This is known as the IMRAD (Introduction, Materials, Results and Discussion) structure, which began to be used as a standard in the 1940s and has since become the main pattern for research articles in many disciplines. It provides an easily understandable structure to separate out the different parts of your work. This classical structure does not fit some disciplines, such as sociology and economics, and most medical journals use a different structure. For example, the journal *Nature Medicine* prints the Methods section last, and in smaller type.

The IMRAD structure is very common in the natural sciences, and a clear understanding of how each part is put together will be useful to most scientists. Note that, as far as publishers are concerned, the title, authors, addresses and abstract are also essential parts of the paper.

3.3.1 Title

It is extremely important to write a good title for a paper. The title attracts the interest of the reader and it is used in bibliographic information services, so it needs to be accurate and informative. The object is to include as much information as you can in as few words as possible. Put the most important part of your work at the start of title, where it will be easiest for the reader scanning a list to see.

You can write your title as one statement, or use the main/subtitle format.

For example, you can write:

Effects of drought, aging and phosphorus status on leaf acid phosphatase activity in rice

Or you can write:

Acid phosphatase activity in rice leaves: effects of drought, aging and phosphorus status

Readers will assume that the subject that comes first in the title is the main focus of the paper, so be sure to reflect that in the paper.

There is a third way of writing a title; that is to make a statement:

Acid phosphatase activity in rice leaves is decreased by drought, aging and phosphorus status

This is a very clear approach, almost a mini-summary of the paper.

3.3.2 Authors

The first author should be the person who carried out most of the work reported, with other workers mentioned in decreasing order of contribution. The scientist who oversaw the work is usually placed last. All people who are listed as authors must be aware of the paper, must have agreed to be named as an author, and must have had the opportunity to contribute to and comment on the paper. Some journal websites comment on authorship, so check on the website of your target journal.

Give the names of all authors, in the style the journal specifies. For example, this may be the first name in full, the middle initial only, and the last name in full. Most journals do not print authors' qualifications.

Do not make a distinction between men and women – do not write:

M.E. Williamson and Meryl G. Simpson.

Indicate which author should receive correspondence and proofs (the corresponding author), with their email and full postal address.

3.3.3 Addresses

You should give an address for each author you mention on the title page – that is, the address of the author at the time when the work was done. If any authors have moved, include a footnote with their present address.

3.3.4 Abstracts

An abstract represents the contents of the article in short form. There are three types of abstract: informative, indicative and structured. There is often confusion about the words 'Abstract' and 'Summary'. A summary restates the main findings and conclusions of a paper, and is written for people who have already read the paper. An abstract is an abbreviated version of the paper, written for people who may never read the complete version. So a summary is not the same as an abstract, although some journals call the abstracts of the articles they publish 'summaries'.

Informative abstracts

An informative abstract should answer the following questions:

– Why did you start?
– What did you do, and how?
– What did you find?
– What do your findings mean?

The abstract must be written so that it can be read on its own, for example, if it is output from a bibliographic retrieval system. Do not waste words by repeating the title in the abstract. Keep to 250 words or fewer for an article of 2000–5000 words, and to about 100 words for a short communication, depending on the journal's requirements.

If the reason for doing the study is not clear from the title or the rest of the abstract, state the purpose. Say what you studied and what methods you used. Give your main findings concisely and summarise your conclusions.

Try to mention in the abstract all the main information covered in the paper. Be as brief and as specific as possible, and write with non-specialists in mind. Emphasise the different points in proportion to the emphasis they receive in the body of the paper. Do not refer in the abstract to research that is not in the paper.

Generally speaking, a short abstract should be written as a single paragraph. To help computerised text searching, use significant words from the text in the abstract. Avoid unfamiliar terms, acronyms, abbreviations or symbols; if you must use them, define them at first mention. Use generic names, not trade names, for chemicals and drugs, except when trade names are the most accurate way to describe such substances. Identify living organisms by their Latin (binomial) names.

Do not include tables, diagrams, equations or structural formulae in an abstract, unless it is intended for consideration by a conference organising committee rather than as part of a journal article. Avoid citing other work; if you must include a citation, for example to a paper that inspired your investigation, include a short form of the bibliographic details in the abstract itself – "as D.G. Ngoyo pointed out (*J. Rice Res.* 2005; 4: 2111–13)" – for the benefit of readers who will read only the abstract.

Indicative abstracts

Indicative abstracts contain general statements describing what is in the text, giving readers a general idea of the contents of the paper, but little, if any, specific detail. They are more common in field reports, long papers such as review articles, and for books or chapters in books.

They are the lazy way of writing an abstract; many journals will ask for a more informative version.

Structured abstracts

Some journals now ask for an abstract with a specific structure, especially in the medical area, for reports of clinical trials. This sort of abstract is written mostly as a series of points, although the Results and Conclusions sections should be in sentence form. If your target journal wants a structured abstract, the Instructions to Authors will tell you what headings to use and how long the abstract should be. *Annals of Botany* requests a structured abstract not exceeding 300 words made up of bulleted headings as follows: Background and Aims; Methods; Key Results; Conclusions.

Example of a structured abstract

Background: The scientific article in the health sciences evolved from the letter form and purely descriptive style in the seventeenth century to a very standardized structure in the twentieth century known as Introduction, Methods, Results, and Discussion (IMRAD). The pace in which this structure began to be used and when it became the most used standard of today's scientific discourse in the health sciences is not well established.

Purpose: The purpose of this study is to point out the period in time during which the IMRAD structure was definitively and widely adopted in medical scientific writing.

Methods: In a cross-sectional study, the frequency of articles written under the IMRAD structure was measured from 1935 to 1985 in a randomly selected sample of articles published in four leading journals in internal medicine: the *British Medical Journal*, *JAMA*, *The Lancet*, and the *New England Journal of Medicine*.

Results: The IMRAD structure, in those journals, began to be used in the 1940s. In the 1970s, it reached 80% and, in the 1980s, was the only pattern adopted in original papers.

Conclusions: Although recommended since the beginning of the twentieth century, the IMRAD structure was adopted as a majority only in the 1970s. The influence of other disciplines and the recommendations of editors are among the facts that contributed to authors adhering to it.

3.3.5 Key words

Key words or phrases for indexing are often printed at the end of an abstract. If the journal asks for key words, choose the most important and most specific terms you can find in your paper. Refer to previously published articles in the journal of choice for guidance. To help readers to find your paper, do not include very general topics such as 'soil' or 'potato'. Be specific, to allow readers to focus on your work. Include the binomial of the main species you are working with. Note that essential words in the title should be repeated in the key words since these, rather than the title, are used in some electronic searches.

> *The IMRAD format is a well established approach to writing and publishing scientific research*

3.3.6 Introduction

The Introduction should answer the questions "Why did you do the work?" and "What did you want to find out?" It should contain three parts:

– the background to the work and a brief review of the relevant literature, to allow the reader to evaluate the present work;
– the logic that led you to do the work, and your hypothesis;
– a clear statement of the objectives of the work.

You need to show the logical development of your theory or objective within the context of existing work. Explain how your hypothesis came about, briefly reviewing previous published work on the subject. Use references to support everything you say. Most authors initially make the Introduction too long by including too much background material, for example, "This crop is one of the most important food crops in the world". If you have exceeded two pages of typing, you have probably written too much.

3.3.7 Materials and Methods

Here the questions are "What did you use?" and "What did you do?" In this section, you only describe the materials you used, and the methods you used in the work. You do not need to interpret anything. However, you must make sure you have described everything in sufficient detail so that another scientist could repeat your experiment after reading the description.

Justify your choice of one method or treatment over the others available. State the assumptions that you have made. This will allow your readers to understand the purpose of the methods you are about to describe. Follow a logical order; this section falls naturally into two sections: the Materials first, then the Methods.

Materials

Describe all the materials – chemicals, animals, plants, equipment, etc. – that you used. Identify chemical compounds (fertilisers, etc.) so that other workers will be able to obtain the same materials. If you use trade names, you should include the full chemical name or active ingredient the first time you mention it. Some journals ask you to give the name and address of the supplier or manufacturer of the material.

Use internationally recognised standards for naming materials, and also use metric units, standard nomenclature, etc. Give the full genus, species, race, strain, cultivar or line of any experimental plants, animals or microorganisms you used. Species names can be abbreviated once they have been fully described.

Check the journal's Instructions to Authors for correct usage and terminology.

Methods

In this section, you answer the questions "What did you do?" and "How did you do it?". Describe your experiments in a logical order. If you have used well known methods, just give their names and a reference, but if you made any changes, these should be explained. The readers of the paper will be scientists themselves, so you do not need to describe familiar things in detail. Be brief, but do not leave out important information such as sizes or volumes.

Describe the statistical techniques you used, but do not go into detail. Most tests are well known and do not need much description. If a technique is not so well known, then you can give a reference. Only if the method is new or original should you describe it in detail. If a journal demands a certain type of statistical treatment, then you must follow the recommendations exactly.

3.3.8 Results

In the Results, you describe what happened in your experiments. You can present your results making no comment on them, giving your own interpretations later in the Discussion section. Another approach is to interpret the results up to a point, to make some connections between the different statements, but to give more detail in a separate Discussion section. A third way is to combine the results with a discussion of each point.

Whichever way you choose, you should present the results in a sequence that corresponds to your original objectives. Report any negative results that will influence your interpretation later on. Present all the relevant results in this section so that you do not need to introduce new material in the Discussion. Remember your original purpose. In an experimental paper, your objectives tell you what you should be writing about. Results that do not relate to them should not be mentioned.

Many journals nowadays will allow you to upload large tables or other forms of data to a dedicated website and allow you to link to that site in your paper. This allows you the freedom to publish complete data sets, without trying to include them all in your limited-size paper.

3.3.9 Figures and tables

Write in relation to tables and figures that you have already prepared. There is no need to repeat boring lists of statistics in the text when they are already in the tables or figures. Describe the overall results, not each individual value.

Do not say:

"The results of experiment A are reported in Table 1";

say instead:

"The treatment used in experiment A gave 50% greater yield than the control (Table 1)".

Make sure you mention every table and figure in the text, and include each table and figure that you mention. See Chapters 8 and 9 on how to prepare tables and illustrations, and Chapter 10 on statistics.

3.3.10 Discussion

In the Discussion, you must answer the questions: "What do my results mean?", "Why did this happen?" and "What are the implications?". This is the most thoughtful and demanding section of the paper, but also the most important. You must interpret your results for the readers so that they can understand the meaning of your findings. You need to distinguish among a mass of information and select that which is most relevant to your argument. Use a series of findings or statements to come to a clear conclusion. This conclusion must match your originally stated objective.

Use the Discussion to interpret your results, giving particular attention to the hypothesis or objectives that you put forward in the Introduction. 'Discussion' is really short for 'Discussion of results'. It is not a section in which you review the literature on the subject. All literature cited must have the function of supporting arguments about your results. Relate your findings to previous work, and if they do not agree with your work, then discuss why not. Discuss any negative results.

In this section, you discuss why something happened and why things did not, highlight the strengths and explain the weaknesses of your work. You discuss the relevance of your research to the specific field, point out how it relates to other fields, and make recommendations from your work. You can also mention work in progress, and point out unanswered questions and possible avenues of further research.

Say what is important, with statements such as "The most important aspect of these results is …". But do not use this formula too often, as readers will quickly tire of hearing how 'important' your work is.

One of the most common faults of the Discussion is that it is too long. It may be difficult to follow, or too much data may be repeated from the Results.

In the Discussion, you should generalise, make comparisons and draw conclusions.

3.3.11 Claims and evidence

The central element in every report is its major claim or its main point. You cannot just make the claim. You need:

– good reasons for the claim;
– reliable evidence to support it.

Your evidence needs to be substantive, contestable and explicit:

– substantive – having a firm basis in reality, and so important or meaningful
– contestable – able to be defended during an argument;
– explicit – clear and detailed, with no room for doubt.

Your claim is supported by evidence, which must be accurate, precise, sufficient and authoritative (reliable because it is true and accurate).

Accurate (correct)

Your data must be correct above everything else. Any suspicion that your information is not accurate will make the reader disbelieve your work. Ask yourself, "What evidence am I certain of?". Then question what evidence could be more reliable. You can include questionable evidence if you acknowledge its quality, and you explain anomalies in the data. In fact, highlighting such problems reinforces the credibility of your other data.

Precise

You should be precise in presenting your data, corresponding to your data-gathering techniques. Do not be over-precise, or too vague, and always quantify your claims. You need to present data in the form that best illustrates what you want to demonstrate. You also need to digest raw data so that the underlying patterns and trends are obvious. This is usually done using statistics, tables, figures and graphs. Spell out what you want readers to understand. Do not assume a trend that is obvious

to you will be obvious to the reader. Introduce a figure or table by pointing out what you want readers to notice, and explain why this is interesting.

Sufficient

You need to present enough data to convince your reader that the claims you make are based on enough evidence. For example, many agriculture journals will not accept papers based on data from one growing or cropping season. They want to see repeatability demonstrated in the data.

Authoritative

All your claims need to be supported by evidence, either from your own data or from the literature. Reference material needs to be primary (that is, from journals or conference proceedings) and current. A list of references that is out of date is not convincing. Secondary sources, such as book references, also need to be authoritative rather than popular.

3.3.12 Conclusions

Often you will not need to write a Conclusions section because you will have already stated your main conclusions in the final section of the Discussion. You should certainly never include a Conclusion just to repeat what you have said in the Discussion. However, if your results and the subsequent discussion have been especially complicated, it may be useful to bring all your findings together.

3.3.13 Acknowledgements

Here you should acknowledge technical help and advice that you received from others. Bodies or individuals granting money that supported either the research or the authors of the paper should be mentioned. Keep this section short.

3.3.14 References

See Chapter 7 on how to cite and list references.

3.4 Resources

3.4.1 Useful websites

Guide to writing: http://classweb.gmu.edu/biologyresources/writingguide/ScientificPaper.htm

3.4.2 References

Day, R.A. and Gastel, B. 2006. *How to Write and Publish a Scientific Paper* (6th edn). Greenwood Press, Westport, CT, USA.

3.5 Exercise – The structure of a research paper

List the five most popular journals in your field. Find samples of articles in these journals online.

Look at the structure of the articles in these journals. Are they using the IMRAD structure? How well do you think it works? Could there be an alternative structure?

Find one research journal that does not use this structure. Why do you think this is?

Write first an indicative, then an informative, abstract of one of your own papers or reports, then write a corresponding structured abstract. Which do you think is best?

Paul Stapleton

Writing a research paper

4

4.1 Introduction

Many young scientists think that writing a paper is difficult and time-consuming. However, approaching the task systematically, just like any other work in science, can make the job easier. Breaking the process into steps that build on each other is a process that can simplify writing a research paper.

4.2 Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– construct a skeleton or 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 your chosen journal;
– submit a paper a suitable format, either online or on paper.

4.3 Initial steps

Some scientists can conceive a paper in their head and just start writing, but most people cannot do that. The easiest way to write a paper is to plan it first, get all the material together, and then start writing. But before you can start planning, you must have something to say – a message to describe. You usually need to look at all of your research and select part of it as the content of an individual paper. Most research journals are looking for "significant results" or "papers reporting a significant advance in knowledge". That will be one of the first questions the editors of the journal will ask themselves when they receive your paper. Is the information in the paper significant, as well as new?

You must try to 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 reports significant results." What you write will have to stand up to the examination of the editor and the criticism of the referees.

4.4 Journal style

Once you have decided on a journal, you should prepare your manuscript in that journal's style and format (see Chapter 2). Most journals publish detailed guides to authors or 'Information to Contributors'. They are usually available online, as a separate booklet, or published in the journal itself, often in the first or last issue of the volume or year. You must obtain a copy, read it carefully, and apply all the requirements to your manuscript. If someone else is actually preparing or typing the paper, make sure they understand the requirements too.

4.5 Making a plan for the article

Look at the way the articles in the journal you have chosen (see Chapter 2) are subdivided. The different sections (see Chapter 3) will give you a first guide on how to start planning your article. It is best to use the subdivisions that are most common in the journal. The editor will prefer it and so will the readers, as they are all familiar with the format. A logical arrangement makes specific information easy to locate. However, if you have good reasons for making up your own divisions, you should go ahead and do it. If it is sound, the editor will usually accept your plan. So long as the layout you decide on is suitable for the material, most journals will respect your decision.

The questions you answer when planning a paper help you break the paper down into its elements, which can be explained as follows:

– what was known, and what was not known, before the investigation was started;
– what the work was expected to show, or the objectives, and the hypothesis under test;
– setting and conditions of the experiment that eliminate variation;
– experimental plan;
– methods used;
– how the data were collected;
– methods of analysing the data and statistical techniques;
– results obtained;
– validity and meaning of the results, and conclusions to be drawn from them;
– implications of the results in relation to other work;
– directions for future work;
– references to other work in the field.

4.5.1 Prepare the figures and tables first
It is usually best to put your results in graph and table form before you start writing. Usually you will have a lot of data, and you must select parts of it to support the arguments in your paper. While you are doing this, you will also be deciding exactly what you want to show, and the best ways to illustrate your findings.

4.5.2 Build up the paper in sections
The basic idea is to build up your paper step by step. Look at the list of elements above, and start thinking about the answers. This will help you start to develop an outline of the paper.

First, decide on the main divisions of the article. That means you have an overall plan that will help you in your next task, which should be to make separate plans for what you will include in each section. Look at a single heading, for example, the Materials and Methods. You can immediately break that down into a Materials section and a Methods section. Now think about what materials you did in fact use. You can write down headings such as Chemicals, Animals, Equipment, Soils, etc. That is, you start making a list of subdivisions or sections.

Many word processing programmes, such as Microsoft Word, have a document-mapping facility that allows you to review all your headings easily. What you have is a list of section titles that will go together to make up, for example, the Materials part of the Materials and Methods section. You are already developing a plan of the paper. You can do this with each part of the article in turn, planning the content of each section. Spend some time doing this, because writing from a plan is always easier than writing from start to finish.

4.5.3 Expand 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. But if not, you can continue your step-by-step approach, making notes on the content of each part of each section. Once you have finished making notes, what you have really done is finished writing the paper. From now on, the paper should write itself.

"

Breaking the task into steps that build on each other is a process that can simplify writing a research paper

"

4.5.4 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? Could a table be better expressed as a graph? Do you really need all those long tables? Can they be expressed more simply as figures? If you do not do it now, the editor and referee will certainly ask you to do it later. Have you left anything out? Is there going to be too much detail? Try to ask yourself the most difficult questions now, so that you can change the structure of the paper before you become too involved in writing.

4.6
Start writing

Sometimes it is difficult to start writing. Consider your working day, and when you can work on your paper. You need to develop a working method that will suit the way you write in the time you have available. You might choose to begin writing the easiest section, the 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 what happened. By then, you should be involved with the paper and ready to start on the most 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.

Once you start writing, you should write as quickly as you can. Do not worry about language, grammar, style or spelling. Just write down as much as possible while the flow of whatever section you are working on is clear in your mind. Try to write simply. In this way, you will lay down a basis to work on later. It is always easier to come back to something than to start filling in a blank screen. Concentrate on scientific content and nothing else.

Write in the language that is easiest for you. You can always translate it later – that is just mechanics. Most important at this stage is to turn your notes into written language. 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.

4.7
Revising content

Once your first attempt is finished, you can start revising the paper. You should always be prepared to revise what you have written. Ask yourself:

– 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?

Review the scientific content of the paper until you are certain it is correct, then put the paper aside for several days, then reread it. A short time away from the work gives you a perspective that will allow you to judge what you have written. Once you are

satisfied with the standard of your work, format the paper in the style of the journal. Then give the article to your co-authors or some colleagues 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.

4.8
Revising language and style

By now, you should be confident of the science in your article. Next, you need to look at the language and style, so that the paper can be read and understood easily. This is one of the things that editors will be looking for. Use a spell checker; however, most grammar checkers cannot handle scientific text very well, without "training" (see Chapter 5 on writing English).

4.9
Check the references

At this stage, you must check that all the references listed are mentioned in the text. Then look at it the other way around, and check that all the references in the text are included in the reference list. If you are using a "reference assistant" program such as EndNote, then this process is easier; but you may be doing it manually. If you are using the numbering system (see Chapter 7), tick each reference in the list as it is cited in the text, and carry on. Make sure that all references are numbered in the order they are mentioned. If you are using the name/date system (see Chapter 7), you have to be more careful. Check first that the references in the list are in the correct order, either in order of citation or, more commonly, in alphabetical order. Check then that the spelling of the authors' names in the text corresponds with that in the list. If they are not the same, check the original, and also check the date.

How many authors are there in the reference? If there are two, then both names should be given in the text. If there are more than two (or sometimes three) names in the reference, you should use the first author's surname and "*et al.*" in the text (see Chapter 7). Should *et al.* be in italics? That is another question you should answer by looking in the journal. Is the date in the text the same as that in the list? Should you also be using a, b, c to distinguish references by the same authors from the same year?

Work through and check every page of the typescript and every reference. When you have finished, check that you have ticked every reference in the list. If some are not marked, then you should 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.

4.10
Handling the figures and tables

See Chapters 8 and 9 on how to prepare figures and tables. Chapter 10 deals with statistics in your paper, but check in the publishers' Instructions to Authors on how to handle your tables and figures. You may have to collect all the tables at the end of the paper and submit all the figures as separate files. Many authors prefer to paste their figures into the computer file where they are mentioned, but this may cause problems for the publisher. Check on the journal's website.

4.11
The final manuscript

Remember that the journal will expect you to prepare your paper according to the instructions of the journal. You might not think this is very important, but the journal editor will. You only have to worry about 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.

Look again at the journal and its Instructions to Authors. Some of these are very detailed. Note how wide the margins of the page must be, the line spacing, whether headings should be on the left or in the middle of the page, how to indicate bold face and italic letters, etc. Number the pages and insert a header in the computer file that includes your name and a short title of the paper.

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

4.12
Preparing a covering letter

Some journals ask for a covering letter that gives basic information, such as contact details of the corresponding author, the title and authorship of the paper. You might also be asked briefly to describe the specific area of the paper and the scientific strengths that qualify it for consideration by the journal. The editor will use this information to check that the paper is within the scope of the journal, and which referee to send it to.

4.13
Submitting the paper

Many journals today actively encourage you to submit your paper by email (see Chapter 15). It is faster than posting manuscripts around the world. Check on the journal's website how to submit a paper electronically. Some journals have their own on-screen submission forms. These might take a while to complete, so be sure you have enough time on the computer to complete the procedure, and all the files you need, in the correct format. Note, for example, that the *American Journal of Agricultural Economics* will accept manuscripts only in pdf format (http://ajae.arec. umd.edu/newsubmissions.htm).

If you are submitting a paper copy (some journals require this as a supplement to email submission), check that you have the right number of copies, then wrap up the whole package securely. 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 select the right one. Some journals have different editors dealing with different parts of the world, or different subject areas. All this information is usually on the inside front cover of the journal, or on the website, so make sure you read all the information carefully. Send the manuscript via airmail, and wait for an acknowledgement.

Online submission allows international authors and referees to become a part of the journal's community. As an author, you can check on your paper's progress while peer review takes place. Usually, everything is managed and tracked online, so the whole process is logged and accountable. The process is designed to be simple for everyone involved.

4.14 Resources

4.14.1 Useful websites

Science publishing trends, ethics, peer review, and open access
– http://journalology.blogspot.com

Writing in English
– http://bookshop.europa.eu/is-bin/INTERSHOP.enfinity/WFS/EU-Bookshop-Site/en_GB/-/EUR/ViewPublication-Start?PublicationKey=HC3010536
– www.oxfordjournals.org/our_journals/annbot/for_authors

Online submission
– www.oxfordjournals.org/for_authors/online_submission.html

4.15 Exercise – Review of published papers

You will receive copies of previously published papers. Analyse these papers, looking at each with the following questions in mind:

– Does the paper report new, significant or innovative work?
– Is the title accurate and informative?
– Does an introduction describe the background and objectives of the work?
– Are the methods explained clearly enough for the reader to repeat the work?
– Are the results valid, and properly presented and described?
– Is any criticism or review well thought out, supported and researched?
– Do any parts of the paper need to be shortened, or lengthened?
– Is the paper adequately referenced?
– Are all figures, tables and photographs necessary?
– Can the paper be improved in any other way?

Can the paper be:

– accepted as it stands?
– accepted conditional on recommended revisions? – if so, list the revisions
– submitted for reconsideration after recommended revisions?
– rejected?

If you have brought a paper of your own, the group could analyse it for you in the same way – if you are willing!

Paul Stapleton

Scientific style and English in research papers

5

5.1
Introduction

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.

5.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– become aware of good writing style and how it can increase comprehension;
– differentiate between the elements of good and poor style in writing research papers;
– correct the style and English of a paper to enhance readability.

5.3
Writing in the English language

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 about, 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. The following points could help when you are writing and revising your paper:

– use simple and direct language;
– avoid abstract nouns made from verbs;
– avoid noun clusters;
– be aware of errors of meaning and form;
– avoid jargon;
– be aware of sentence structure;
– use the correct verb forms (tense and voice);
– use personal pronouns (sometimes).

5.3.1 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 utilised was undeniable.

This is verbose. Much better if you write exactly what you mean in a direct and simple way:

The fertiliser we used was effective.

Use simple verbs such as use instead of utilise. 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 along with preferred, shorter alternatives. Always try to use the simple expression. Avoid buzzwords 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 together 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 thus misunderstand the meaning. This is also 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 the numbers stayed the same, or the 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.

5.3.2 Nouns from verbs

Abstract nouns are often made from verbs. This can be done quite easily: the verb to measure gives the noun 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 of the action is important: "Yilma (1992) measured the variation." Other common examples of this are production from produce, interpretation from interpret, and 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 to 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.

But, with better and fewer words:

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

5.3.3 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 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.

5.3.4 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. It is much better to use several simple words that give the correct meaning and are easily understood. There are many words in English that look almost the same but have different meanings, sometimes subtly – for example, various, varying, variable.

Remember that words such as data, phenomena and criteria are plural, not singular; equipment and information are always singular and never have a closing "s".

5.3.5 Jargon

According to the *Oxford English 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 specialised 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.

For example, 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.

5.3.6 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 sentence 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 derivatising 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 derivatising 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."

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 more easily if the subject and verb are first identified and brought to the beginning of the sentence. A short list could 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."

5.3.7 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 four 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 fertiliser 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. But the contemporary trend is to use personal pronouns sometimes for a livelier style and easier reading.

5.4
Lists

Lists are often a good way to present material clearly and concisely. All items in a list should be grammatically parallel in their construction. Sometimes, however, an author starts a list one way and then switches gear, changing to a different construction half-way 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 bullet points.

5.5
Quantification

Hedging, or qualifying a statement, is done when you are not certain of the truth of what you are writing. You may 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.

5.6
Unbiased language

Watch carefully to make sure 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 probably inaccurate, as a high percentage of African farmers are women.

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

" …make sure your paper does not include hidden biases in its language "

5.6.1 Man as a verb

Do not use "to man" as a verb. Work, staff, serve, operate and other alternatives may be used instead –

not:

"The emergency room must be manned at all times."

but:

"The emergency room must be staffed at all times."

5.6.2 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 here 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 "man-made" are available, including hand-made, hand-built (in this case "man-" comes from the Latin *manus*, hand); also synthetic, manufactured, fabricated, machine-made, constructed.

"Manpower" can usually be replaced by personnel, staff, workforce, workers, human resources.

5.6.3 Man as a suffix

Again, with thought, sentences may be rewritten –

not:

"A spokesman of the corporation will meet with the press at 4 pm."

but:

"A representative of the corporation will meet with the press at 4 pm."

not:

"Englishmen are said to prefer tea."

but:

"The English are said to prefer tea."

See Table 5.1 for additional recommended alternatives.

Table 5.1
Alternative terms

Sexist term	Recommended alternative
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 workers
Forefathers	Ancestors, forebears
Foreman	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; the term has become debased and its use is often jocular
Man, mankind	People, humanity, human beings, humankind, the human species, the human race, we, ourselves, men and women, Homo sapiens, one, the public, society
[to] Man (verb)	Operate, work, staff serve at (or on, or in)
Man and the biosphere	While existing titles of programmes, documents and so forth cannot be changed, avoid man, he, etc., in all cases in new titles

Table 5.1
Alternative terms (continued)

Sexist term	Recommended alternative
(to) Man a project	To staff a project, hire personnel, employ staff
Man-hours	work-hours, labour time
Man-made	Hand-made, hand-built, human-made, synthetic, manufactured, fabricated, machine-made, artificial, of human construction, of human origin, built-up, industrial, human-induced
Manpower	Staff, labour, workforce, personnel, workers, human resources, human power, human energy
Man-to-man	One-to-one, one-on-one, person-to-person trader
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 non-gender-specific term when the reference is indeterminate
Workman	Worker
Workmanlike	Worker efficient, skilful

"Language and style are like packaging: good packaging can never make up for poor content, but attractive packaging enhances good content"

5.6.4 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" and "his or her" is clumsy, and 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 "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 be eliminated by repeating the noun to which they refer, but this can also sound clumsy. Instead, a synonym or substitute for the word may 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.

5.6.5 Assigning gender to gender-neutral terms

The assignment of gender to common-gender nouns may distort the information being presented, as when terms such as 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 60–80% 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."

5.6.6 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 gender-specific modifiers can be deleted.

5.6.7 Personification

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

5.6.8 Girls, ladies, females, women

These words have strong overtones of immaturity and dependence (in the case of girl), and of decorum and conformity (in the case of lady). They can be very offensive, as for example in:

"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 the formula "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: two females and one male."

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

"The project team of seven women and five 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.

5.6.9 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 scientific or official writing.

5.6.10 Trivialising

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" whereas men "disagree".

5.6.11 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 and less respect –

not:

"Dr J.D. Morgan and Dr Judith James"

but:

"Dr J.D. Morgan and Dr J.E. James".

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.

5.6.12 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.

"Good scientific writing communicates in simple terms, even though the subject may be complicated"

Paul Stapleton

Dealing with numbers, units, nomenclature and abbreviations

6

6.1
Introduction

Science publishers are very particular in the way that they present numbers, units and other terms. There are some standards, but different journals follow their own rules for many of the numerical aspects of writing papers. Journal editors want all the papers in their journals to use the same forms of units, abbreviations, etc. in a standard format. You should study carefully papers in previous issues of the journal you have chosen, and look at the Instructions to Authors for guidance. The styles used in science writing are very specialised. This chapter presents rules and methods of handling numbers, etc. that are most common. More specific information will be found on the website of the specific journal.

6.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– understand the importance of correct usage and nomenclature in scientific publishing;
– use the units, abbreviations, nomenclature and terminology that are common in research papers.

6.3
Abbreviations and symbols

Abbreviations and symbols can have several forms; simple English words can appear in various forms as well. In fact, many words in English can have different forms, each one of them correct (e.g. appendices, appendixes). There are many different ways of presenting and using numbers, units and abbreviations. Even a simple unit can have a number of variations, for example:

– 29 kg/ha (space before unit);
– 29kg/ha (no space before unit);
– 29 kg per ha;
– 29kg per ha;
– 29 kg ha^{-1};
– 29kg ha^{-1}.

6.4
Numbers

A number is more quickly read and understood than a word, for example, two thousand and six compared with 2006. A standard convention with numbers is that, if there is no unit, then write out the numbers from one to nine in words, and use figures for numbers of 10 and above, for example, "more than two" and "over 500".

In either style, start a sentence with words:

"Fifty-two of the respondents were…"

Use numbers with all units of measurement, even those below 10:

3 ml; 5 m; 10 kg.

A standard convention in technical and scientific papers is to put a single space in between the number and the unit (5 ml) unless the style guide specifically states otherwise.

The Système International d'Unités (SI) (see below) recommends that numbers of four digits should be written without any space, comma or point:

1000; 4567

Five-digit numbers should be written with a space after the third figure:

10 000; 98 765.

There is a very good reason for this. In some parts of the world, the decimal point is marked with a comma, but in other parts it is a full stop or period, so 10,500 means ten point five to some people and ten thousand five hundred to others. To avoid this, SI recommends using a point for the decimal (10.5 = ten point five) and a space for every three zeros from the decimal (21 000 = twenty-one thousand; 42 000 000.5 = forty-two million point five).

In a table or column with a mixture of values, but not in text, four-digit figures should also be written with a space so that they line up neatly:

```
23  678
10  456
 6  990
 3  000
```

Adjust your units to avoid too many zeros in numbers less than one, for example, 45 mg, not 0.000 45 g. Another way to avoid this is to use numbers with factors of 10 after them:

$3\ 500\ 000 = 3.5 \times 10^6$.

Use billion to mean 1000 million. To avoid ambiguity with former usage (a million million), define this in an abbreviations list or at first mention (by putting 1000 million in brackets).

Some journals use the negative exponential with units, for example, 560 mg kg^{-1}, rather than 560 mg/kg, although the SI web page uses the mg/kg form.

The numbers in ranges are usually written in full, for example 1992–2003, to avoid any ambiguity. Some journals require the form 1982–03. Check in the instructions to authors. Note that the US usage "1994 through 1996" is very convenient as it means "from the start of 1994 up to the end of 1996", although some journals will discourage this use.

6.4.1 Non-breaking spaces

If you are using the Microsoft Word program, use a non-breaking space (Ctrl+Shift+space) between numbers and units and five-digit+ numbers. This will keep the whole expression on one line, rather than allowing Word to break it in two if it comes at the end of a line. Ctrl+Shift+hyphen will give you a non-breaking hyphen. You can also insert these by using Insert/Symbol in Word.

6.5
Dates

There is real danger of confusion when writing dates, because 4/8/10 means 8 April 2010 in the United States and 4 August 2010 in Europe. Because of these different conventions, it is most clear to write dates out using a word for the month: 10 November 2003 or 10 Nov 2003. No punctuation is needed in a date (4 December 2005), nor is it necessary to write 4th December.

It is seems most logical to use the series day, month, year, as that goes from smallest to largest. However, the International Organization for Standardization (ISO) recommends an all-numeric expression (often seen in computer use). This standard (ISO 8601) is based on putting the largest types of numbers first and the smallest numbers last, giving year-month-day:

20051110 or

2005-11-10 or

2005 11 10

also:

2005 11 10 1240 (time) and

2005 11 10 1240 45 (time and seconds).

6.6
SI units

Most journals use the metric system based on the Système International d'Unités (SI). You will be familiar with most of these. You should always express all quantities as metric units. If you are using traditional or local units, or a unit that may be well known only in one country, you should always include a metric equivalent so that other workers can fully understand the amounts you are talking about.

Note that SI uses these spellings:
– metre (and litre)
– kilogram.

Prefixes for SI units are listed in Table 6.1.

Table 6.1
Prefixes for SI units

Fraction	Prefix	Symbol	Multiple
10^{18}	exa	E	1 000 000 000 000 000 000
10^{15}	peta	P	1 000 000 000 000 000
10^{12}	tera	T	1 000 000 000 000
10^9	giga	G	1 000 000 000
10^6	mega	M	1 000 000
10^3	kilo	k	1 000
10^2	hecto	h	100
10	deca*	da	10
			1
10^{-1}	deci	d	0.1
10^{-2}	centi	c	0.01
10^{-3}	milli	m	0.001
10^{-6}	micro	μ	0.000 001
10^{-9}	nano	n	0.000 000 001
10^{-12}	pico	p	0.000 000 000 001
10^{-15}	femto	f	0.000 000 000 000 001
10^{-18}	atto	a	0.000 000 000 000 000 001

*May be spelled deka.

6.7
Nomenclature

The dictionary defines nomenclature as "a ... system of names for things; terminology of a science, etc.; systematic naming". There are different systems of nomenclature for different fields of science. There are nomenclatures for animals and microorganisms, chemical and biochemical nomenclatures, physical and mathematical nomenclatures.

The important point is that each system of nomenclature is well recognised, published and understood by a wide circle of scientists, with strict rules, so that any new name made up under these rules is instantly understandable to anyone who knows the rules, or who knows where to look for them.

There are standard ways of naming animals and microorganisms, chemicals and biochemicals. Most journals' Instructions to Authors include detailed explanations of the nomenclature needs for papers submitted, and their web pages contain plenty of advice.

Chemical, biochemical and molecular biological nomenclature should be based on rules of the International Union of Pure and Applied Chemistry (IUPAC) and the International Union of Biochemistry and Molecular Biology (IUBMB). Chapter 16 of Huth (1994) gives guidelines (see Resources at the end of this chapter).

6.8
Abbreviations and acronyms

6.8.1 Abbreviations

Abbreviations, shortened forms of a word or term, are very common in science. 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.

The danger with abbreviations is that the reader may not understand the abbreviation. When you use abbreviations, be sure to explain them on first use, and perhaps include a comprehensive list of them in the paper as well. The safest way is to use the term in full the first time it occurs in the text, and give the abbreviation you intend to use in brackets. From then on, you can use it quite safely. You can also include a list of the abbreviations or acronyms you use so that readers can look them up easily.

Journal editors are always watching for correct use of abbreviations in the papers they publish. Most have a list of terms that may be used, and others that may not be. Different journals will have different policies. You will find a description of the use of symbols and abbreviations in almost all Instructions to Authors.

6.8.2 Acronyms

An acronym is a word formed from the initial letters of other words, for example, WHO (World Health Organization), IUPAC (International Union of Pure and Applied Chemistry). As a general principle, acronyms do not have a full point between the capital letters.

6.9

Symbols

Symbols are similar to abbreviations or acronyms, but they are usually shorter, for example, A_{260nm} for absorbance at 260 nm, P_i for inorganic phosphate, Ω for ohm. Many symbols are very widely accepted and do not need definition (such as %).

6.10

Species names

Taxonomy is a complicated subject, and the names of particular species need to be given very clearly in any paper you are writing. You should take care to find out and give the complete species name (the full binomial name in Latin) in the title, the abstract, and the first time it appears in a paper, in italic type. Afterwards the generic name is abbreviated to a single letter, for example, *Escherichia coli* becomes *E. coli*.

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

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

Compositae Diptera Arthropoda

Often a scientific name is the same as the common name. In these cases, the word is not put in italics or capitalised:

Acacia acacia.

6.11
Resources

6.11.1 Useful websites

The International System of Units (SI)
– www.bipm.org/en/si/
– http://en.wikipedia.org/wiki/International_System_of_Units

Numbers
– http://en.wikipedia.org/wiki/Names_of_numbers_in_English

Recommendations on biochemical and organic nomenclature, symbols and terminology
– www.chem.qmul.ac.uk/iubmb
– www.chem.qmul.ac.uk/iupac

Plant names
– www.ipni.org/ik_blurb.html

Animal names
– www.iczn.org

6.11.2 References

Council of Science Editors (ed.) 2006. *Scientific Style and Format. The CSE Manual for Authors, Editors, and Publishers* (7th edn). Council of Science Editors, Wheat Ridge, CO, USA.

Greuter, W., McNeill, J., Barrie, F.R., Burdet, H.M., Demoulin, V., Filgueiras, T.S., Nicolson, D.H., Silva, P.C., Skog, J.E., Trehane, P., Turland, N.J. and Hawksworth, D.L. (eds) 2000. *International Code of Botanical Nomenclature (Saint Louis Code) adopted by the XVI International Botanical Congress, St Louis, Missouri, July–August 1999. Regnum Vegetabile 138.* Koeltz Scientific Books, Königstein, Germany.

Huth, E.J. 1994. *Scientific Style and Format. The CBE Manual for Authors, Editors, and Publishers* (6th edn). Cambridge University Press, Cambridge.

Paul Neate

Citations and references

7

7.1
Introduction

There are many different styles for citing and listing references; every publisher and every journal seems to prefer its own variations. There is not a "right way" and a "wrong way" of citing and listing references, but there are many ways, some with major, some with minute stylistic differences. Butcher et al. (2006) state "The exact punctuation within references does not matter, provided all the necessary information is given clearly and consistently."

For simplicity, the reference examples given in this chapter follow a minimal punctuation style; CTA's own house style is to use full points and commas within author names.

How to choose which style to use? Where possible, you should obtain the Instructions to Authors for the publication for which you are writing, and follow its rules. Such a guide is generally published in the first issue of a new volume of the journal, and on the journal's website. Failing to follow a journal's style creates the impression that your paper was not written with that particular journal in mind. Top journals, in particular, receive far more papers than they can possibly publish, and you risk having your paper rejected out of hand if you do not follow their instructions precisely.

7.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– recognise the three common styles of citations and 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.

7.3
Common citation and reference styles

There are three common citation and reference styles in the biological sciences:

– name–year system;
– numbered alphabetical list;
– citation-sequence system, most frequently used in medical sciences.

7.3.1 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.

Text citation
"Ajayi (1987) demonstrated…" or "previous research (Ajayi 1987) has shown…";

"Franzel *et al.* (1989) found that…" or "similar to previous findings (Franzel *et al.* 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. Institute of Agricultural Research, Addis Ababa, Ethiopia.

7.3.2 Numbered with alphabetical listing

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

Text citations

 "previous research has shown (2)…" or "Franzel *et al.* (2) showed that…, while Ajayi (1) found…"

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. Institute of Agricultural Research, Addis Ababa, Ethiopia.

Citation-sequence

In the citation-sequence system, references are numbered in the sequence in which they are cited: the first reference cited is numbered 1, the second 2, etc. Citations are indicated by the number of the reference cited. The references are listed in numerical order. Each citation in the text is given a number, superscript or in parentheses, in the order in which it is first mentioned; the reference list is arranged sequentially by number and is not alphabetical. The main name of all authors is given first, followed by initials.

Text citations

 "…previous research has shown1,2…" or "Franzel *et al.*[1] and Ajayi[2] showed that…"

Reference list

1. Franzel S, Legesse Dadi, Colburn F and Getahun Degu. 1989. Grain marketing and peasant production in Ethiopia. Research Report No. 5. Institute of Agricultural Research, Addis Ababa, Ethiopia.

2. Ajayi O. 1987. The effect of different types of farmer participation on the management of on-farm trials. *Agric. Admin. Ext.* 25: 235–52.

7.4
Working with citations and reference lists

"Careless documentation that leads fellow scientists to waste time pursuing a faulty reference should lead to your obliteration from the scientific community."

Martha Davis (1991) *Scientific Papers and Presentations.* Academic Press, New York, USA.

This sentiment might be a little harsh, but it shows the importance of care and precision in citing and listing references.

First, a general rule about citing references: cite only material that you have read yourself. Do not cite material that you have seen only as a citation in the work of others, unless it is impossible to obtain the original document. If you must use such a secondary citation, make it clear that it is such by citing it as, for example, "Bloggs (1883, cited by Smith and Jones 2001)". Give both references in the reference list and add "[Cited by Smith and Jones 2001]" at the end of the reference you have not read.

The explanations and examples given here are for the name–year system. But all the reference systems require the same items of information, largely in the same order.

Within reference systems there are many variations, some minute, such as whether to enclose the year in parentheses; 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 recommended by most science editors' associations is to produce an easily understood citation with a minimum of punctuation marks.

The rules given here, for the name–year system, are those followed by many international agricultural research centres. You should modify them according to the style of your organisation and/or the style of the publication for which you are writing.

Citations in the text

Use no comma between author and year:

(Mungai 1990)
(Mungai and Taylor 1993)
(Mungai *et al.* 1991)
(Mungai and others 1991) [preferred by CBE over *et al.*]
"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'."

If you are giving several quotes from a work, then be specific as to location as follows:

(Mungai 1990 p 33)
(Mungai 1990 pp 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 1990)
[does not appear in reference list]
(Amare Getahun 1988) [see Alphabetical order, below]

7.4.1 The reference list

The reference list 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, as in the following example:

Ajayi O. 1987. The effect of different types of farmer participation on the management of on-farm trials. *Agric. Admin. Ext.* 25: 235–52.

Sequence of references

There are several different schools of thought on how to order references in the name–year system. The following is based on that suggested by Butcher *et al.* (2006).

Each author's publications are listed chronologically within the following groups

Works by a single author are listed before those written in collaboration with others.

Joint works may be grouped in any of the following ways.

– **Alphabetically by co-author** (irrespective of the number of authors) – for example, Jones 1985, 1989; Jones and Abrams 1988; Jones, Abrams and Smith 1986; Jones, Norman, Hazel and Robinson 1982; Jones and Smith 1985

– **Author with one other,** in alphabetical order of second author; **author with two others;** and so on – for example, Jones 1985, 1989; Jones and Abrams 1988; Jones and Smith 1985; Jones, Abrams and Smith 1986; Jones, Norman, Hazel and Robinson 1982

– If there are many **et al. references** in the text, they will be easier to find if works by two authors are grouped as above, and those cited as *et al.* are listed chronologically, whatever the name of the second author – for example, Jones 1985, 1989; Jones and Abrams 1988; Jones and Smith 1985; Jones, Norman, Hazel and Robinson 1982; Jones, Abrams and Smith 1986.

– If you are differentiating **those published in the same year** by labelling them a and b, these letters should appear in the list – for example, Jones, Norman, Hazel and Robinson 1982a; Jones, Smith and Robinson 1982b.

All the co-authors should appear in the reference list, unless there are more than six authors, in which case it is now common practice to list only the first three, followed by *et al.*

"

There are many different styles for citing and listing references; every publisher and every journal seems to prefer its own variations

"

Additional considerations

In any given year, works written by an author precede those edited by the same author.

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

7.4.2 Main components of a reference

The major components in the listing for a journal article, in order, are:

– author
– date
– title of work cited
– name of journal
– volume, inclusive pages.

The major components for a book are:

– author
– date
– title of book
– city of publication, publisher.

The major components for a chapter in a book or a paper in a proceedings are:

– author
– date
– title of chapter or paper
– inclusive page numbers
– title of book or proceedings
– city of publication, publisher.

Author and year

Generally the author's surname or main name should be given first, followed by the initial letter(s) of their given name(s). Note the reduced punctuation in the layout of the author's names in the following examples:

Mungai A ed. 1990. [last name first for all authors, no commas]
Mungai A. 1991.
Mungai A and Taylor B. 1990.
Mungai A and Taylor B eds. 1991.
Mungai A, Taylor B and Ampofo CD. 1993. [no comma before "and"].

Give the names of all authors; do not use "and others" or *et al.* in the reference list. You may use —— (em dash) for successive references by the same author or authors if the preceding author entry is exactly the same.

Names with particles are often a problem. Spelling and alphabetising should follow the personal preference of the author. But determining what that is may not be easy. Wide variations exist, as the following names illustrate:

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

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

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

Often the best approach is to determine how the names have been alphabetised and handled in previously published work.

Many languages and cultures have their own systems of naming and alphabetising. Here are some guidelines on some of these, taken from the style guide of the International Plant Genetic Resources Institute.

Arabic names
The family name of most Arab names comes last, so take the final name as a basis for ordering. Include, but do not take into account (for alphabetising), any prefixes such as ibn- or abu-.

Chinese names
Spell the name as given in the original work. The names are traditionally written with the family name first, so do not reverse the sequence of the names, or use commas, unless the name has been westernised, with initials, e.g. TJ Chin.

Burmese names
The Burmese do not use family names. Take the main part of the name for alphabetising, the initial will most probably be a title.

French names
French names can start with the articles le, la, l', du, de la, etc. Since there is such variety, ignore the articles (see German and Dutch names, below).

German and Dutch names

These can be very confusing. Some Dutch names begin with 'van' and some German names with 'Von'. One approach is to take the main names as the subject and put the rest behind the name, as in:

Klaus, Von, DJL
Meer, van, PH
Veer, van de, TR.

Another is to leave the 'Von' or 'van' where it is, but still read the first letter of the name:

van Meer, PH
van de Veer, TR
Von Klaus, DJL.

Many journals will have their own specific way of treating these names. Be careful that van and Von begin with a capital or small letter, as cited in the original reference.

Indian names

The surname appears last in Indian names. Some Indians have only one name.

Indonesian names

Many Indonesians have or use only one name. If they use two or more, use the last name as a basis for ordering.

Japanese names

The family name comes first in Japan and so should be treated like Chinese names. However, in most journals the name will have been westernised, with the family name last.

Spanish names

Surnames are usually double-barrelled, for example, Hosé Ortega Garcia. Use Ortega for ordering. Ignore words like y and de, go to the start of the surname.

Thai names

The family name comes last in Thai names, so the name should be inverted.

Vietnamese names

The family name comes first and so the order should not be changed.

Ethiopian names

The first name is the person's given name, the last name is the father's given name. Ethiopian names should be written out in full, not abbreviated or reversed.

Title

The title of an **article** in a journal or magazine, or a chapter in a book, is not italicised, nor is it enclosed in quotation marks. Capitalisation is sentence style – capitalise only the first word and proper nouns, as you would in a sentence.

It is common to capitalise the first word and all significant words in **book and journal titles.** The title of a book, or the name of a journal, may be italicised, although this becoming less common. 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

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 italicised, use italics rather than underlining if possible. But note that words that are normally italicised, such as genus and species names, appear in roman if they occur in a title that is italicised.

Often extra information is included in the reference list, 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 following section.

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, increasingly common style is to give the publisher, followed by a comma, then the city of publication (and often the country in which the city is located). 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 fourth example below. If the city is not well known, give the country, state or province to help the reader identify it, such as to distinguish between Cambridge in England (better known) and Cambridge, Massachusetts, in the USA (less well known):

New York: Wiley (or Wiley, New York, USA).
Washington, DC: World Bank (or World Bank, Washington, DC, USA).
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 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.

7.4.3 Examples of different types of reference

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 edn). Clarendon Press, Oxford, p. 157–84. [when citing only certain pages in the book]

Chapter in book

Youdeowei A. 1980. Title of chapter. In: Taylor B and Mungai C, eds. *Title of Book*. New York: Wiley, pp. 222–34.

Singh GB. 1987. Agroforestry in the Indian subcontinent: past, present and future. In: Steppler HA and Nair PKR, eds. *Agroforestry: A Decade of Development.* Nairobi: ICRAF, pp. 117–40.

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 italicise.

Botswana Ministry of Agriculture. 1980. *How Short People Can Plant Tall Trees.* Helpful Leaflet 99. Gaborone: Dryland Research Station.

Dissertation

Kaplan SJ. 1995. Characterisation of leafy vegetables in West Africa [dissertation]. Wageningen University, Wageningen, The Netherlands.

Unpublished reports

In general, it is best to avoid citing unpublished reports, as they may not be readily accessible to the reader of your paper. 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).

If including unpublished reports – such as a paper presented at a conference or report produced for internal use – in the reference list, you should not italicise the title.

Internet sources

Australian National University GIS database [Homepage of Mapping Agricultural Systems in Papua, New Guinea Project (MASP)] [online]. 12 August 2002 last update. Available from: http://rspas.anu.edu.au/lmg/masp.

A note on internet sources – all instances in the body text should give the website address. This can be either within the text, for example:

data from the Australian National University GIS database (http://rspas.anu.edu.au/lmg/masp)

or as a footnote or endnote, for example:

1. http://rspas.anu.edu.au/lmg/masp.

Web pages

Tong J. 2004. Citation Style Guides for internet and Electronic Sources [online]. http://web.archive.org/web/20040727080101/www.library.ualberta.ca/guides/citation/index.cfm

Web page (no author)

Educating America for the 21st century: developing a strategic plan for educational leadership [online]. 1999. www.ilt.columbia.edu/publicAtions/docs/ILT_Plan_new.pdf.

Home page

European Forest Genetic Resources Programme. [Homepage of EURFOGEN]. 2009. www.euforgen.org.

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. 1999) [or personal communication 1999].

7.5
The importance of accurate and complete references

Accurate and complete references allow your readers to follow up on the material you have cited and to explore the implications of your research further for themselves. Providing incomplete or inaccurate references will cause referees to question the thoroughness and accuracy of the rest of your work, and impose a burden on your readers. You should apply the same standards of care and accuracy that you apply to your research, and to documenting your findings, to your reference lists.

7.6
References

Butcher, J., Drake, C. and Leach, M. 2006. *Butcher's Copy-Editing: The Cambridge Handbook for Editors, Copy-editors and Proofreaders* (4th edn). Cambridge University Press, Cambridge, UK.

Council of Science Editors. 2006. *Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers* (7th edn). Council of Science Editors, Style Manual Committee, Wheat Ridge, CO, USA.

O'Connor, M. 1991. *Writing Successfully in Science.* Chapman & Hall, London, UK.

O'Connor, M. 1992. 'With reference to references'. *European Science Editing* 47: 4–6.

University of Chicago Press. 2003. *The Chicago Manual of Style for Authors, Editors, and Copywriters* (15th edn). University of Chicago Press, Chicago, IL, USA.

Paul Neate

Using tables
to present
research results

8

8.1
Introduction

"A good table is worth hundreds of words. A bad table may confuse more than it communicates."

Ian Montagnes (1991) *Editing and Publication: A Training Manual.* International Rice Research Institute, Manila and International Development Research Centre, Ottawa

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 Chapter 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.

8.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– recognise the faults in poorly prepared tables;
– construct well designed tables.

8.3
Planning tables

The first consideration in designing your tables is – where do you intend to publish your report? If you are writing for a particular journal, your first step should be to obtain and follow that journal's style guide. Most journals' guidelines do not specify the dimensions of tables that are acceptable, so look at the size and layout of the journal for an idea of what will fit. Aim to construct your tables to fit across one column or the full width of the page (assuming a two-column layout). If possible, avoid tables that are too wide to fit across the width of a page; consider breaking large tables into several smaller ones.

One thing to remember: do not duplicate information across text, tables and graphics. The data should be reported in only one form. If your data can be reported simply in text, do so – tables and graphics are time-consuming and expensive to prepare and reproduce.

As you write, make life easy for your reader: tell them what the data show, do not expect them to work it out for themselves. For example, do not write "The results of the trial are summarised in Table 1", tell them what Table 1 shows, e.g. "Applying 60 kg N/ha gave the highest yield (Table 1)". But do not repeat numbers in the text when they are already in the tables or graphics. Describe the overall results, not each individual value.

8.3.1 Tables and their characteristics

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

Tables may be constructed using numbers, as in Table 8.1 (which also names the parts of a table); symbols (Table 8.2); a mixture of words and numbers (Table 8.3); or 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 tables. The choice of the method adopted depends on the nature of the information to be communicated.

Table header ··············> **Table 8.1**
Rice production in East Africa

Country	Growth rate[a]		Production[b]
	1970–90	**1981–90**	**1988–90**
Kenya	3.62	4.71	54
Madagascar	1.05	1.98	2310
Malawi	3.41	1.99	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

Column headings ·············> (Country, Growth rate, Production)
Row headings or stubs ·······> (Kenya)
Body or field ···············> (Madagascar 1.05)

Footnotes ··················> Source: WARDA (1992) *Rice Trends in Sub-Saharan Africa*. West Africa Rice Development Association.
[a]Growth rate (%).
[b]Production ('000 t).

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
Species of *Oryza* in Africa

Species	2n	Genome	Origin
O. *sativa* cultivated	24	AA	Asia
O. *glaberrima* cultivated	24	AgAg	West Africa
O. *stapfii* (weed species)	24	AgAg	West Africa
O. *barthii*	24	AgAg	West Africa
O. *longistaminata*	24	A1A1	Tropical Africa
O. *brachyantha*	24	FF	West and Central Africa
O. *eichingeri*	24	CC	East and Central Africa
	48	BBCC	
O. *punctata*	24	BB	Tropical Africa
	48	BBCC	
O. *schweinfurthiana*	24	BBC	Tropical Africa

Source: adapted from Takeoka (1965); *Ng et al.* (1983).

8.3.2 General guidelines

A table should be able to stand alone: casual readers often read the tables and figures to get the main points of a paper before deciding if they want to invest time reading the whole paper. Also, tables are often reproduced out of context (e.g. in another paper, or as an overhead for a presentation).

Every table in a manuscript for publication should have a number and be numbered sequentially: Table 1, 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 summarised data, not raw data.

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.

Keep it simple: create separate tables for separate topics.

Apply logic to the sequence in which data are presented in tables.

Be consistent: use the same sequence of columns and rows in tables presenting similar information.

Use the same units, symbols and terminology in text, tables and graphics, for example, do not use t/ha in a table and then use kg/ha in the text.

Discuss information in the same order in the text as it is presented in the tables and graphics.

Do not put data in a table if they can be easily and clearly presented in the text; a rule of thumb is that the table field should contain at least eight items.

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
Upland/Inland Continuum Programme			
OM Kuller	Netherlands	Agricultural University of Wageningen	Agronomy
C Groen	Netherlands	Agricultural University of Wageningen	Agronomy
D Hartkamp	Netherlands	Agricultural University of Wageningen	Agronomy
BN Diane	Mali	Station de Recherche Agronomique de Sikasso	Pathology
Sahel Irrigated Rice Programme			
S Ducheyne	Belgium	University of Leuven	Soil science
A Leyman	Belgium	University of Leuven	Soil science
MM Gueune	Senegal	University CAD	Entomology
Farm Management			
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	Automechanics
FI N'Guessan	Côte d'Ivoire	CET	Mechanical construction

8.4
Constructing a table

Make column headings short.

Try to avoid abbreviations. If abbreviations are essential, explain uncommon ones (e.g. you do not need to explain "kg") in a footnote to the table, even if you have already explained them in the text.

Always state the unit of measurement, usually in the SI system, either in the table title or in the column heads, as appropriate. If non-metric units are used in the investigation, convert to metric units for publications.

If percentages are used (e.g. in describing solutions), distinguish between percentage by weight (w/w) or percentage by volume (v/v).

Align the data in columns for ease of comparison down the column. In most cases, this will mean aligning numbers on the decimal point.

Data should be rounded for significance: 76.4, not 76.42796.

Think about the accuracy of your data collection: for example, if you are reporting on a small-plot trial, does it make sense to report a grain yield of 5671 kg/ha rather than 5.7 t/ha?

Use a zero (0) when writing data values less than 1, for example, 0.25 kg.

Choose units to avoid too many digits, e.g. 240 µg rather that 0.000 24 g.

Use powers of 10 to avoid numbers with strings of zeros: 39 200 000 should be written as 3.92×10^7. 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 (nd), the item is not applicable (na), or whatever may be the circumstances, using footnotes if necessary.

Do not use numbers with multipliers in column headings as this can cause confusion.

Use appropriate symbols to identify items that are explained in the footnotes, depending on the journal style. These may be superscript numbers ([1, 2]), superscript letters ([a, b]) or symbols (usually the following, in this order: †, ‡, §, ¶). Avoid using asterisks (*) other than for indications of significance. Choose a system that will not be confused with data in the table.

Use a consistent system for indicating statistical significance. One common standard is: * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$. State which test of significance was used.

8.4.1 A practical example

Tables 8.5 and 8.6 are based on tables that appeared in a 2005 issue of *Plant Genetic Resources Newsletter*, and provide a good example of a number of problems that can occur.

Table 8.5
**Biomass production and its contributory
parameters in different cultivars of banana**

Cultivars	Plant parts					
	Whole plant weight (kg)	Leaves + peduncle (%)	Corm + roots (%)	Pseudostem (%)	Fibre-extractable pseudostem (%)	Fibre yield (%)
Poovan	21.83[a]	16.79	27.39	55.82	40.14[b]	0.72[d]
Karpuravalli	36.78[b]	18.92	26.52	54.56	29.22[a]	0.26[a]
Pachanadan	25.73[a]	16.73	31.59	51.68	34.29[a,b]	0.88[e]
Saba	37.63[b]	21.16	36.69	42.16	37.25[b]	0.40[b]
Peyan	37.13[b]	21.98	31.90	49.46	62.29[c]	0.53[c]
Robusta	19.00c	10.50	5.00	52.66	46.23	0.52
CD at 1%	9.3246	NS	NS	NS	10.9030	0.1110

Note: Within a column, values with the same superscript
letter are not significantly different from each other.

In Table 8.5, the independent or fixed variables (in this case, cultivars) are arranged in rows, while the columns are the dependent, or measured, variables. In Table 8.6, the arrangement is reversed. It would be better to have one arrangement for both tables, to help readers orient themselves. Most people find that it is easier to compare numbers or entries running down a column than across a row. In this case, Table 8.5 has the better arrangement.

Another consideration is the sequence in which to present the information. If there is a reference treatment or entry (Robusta, in the case of Table 8.5), it is best to put this in the first or last row. The most important variable, the one on which you want your readers to focus (whole plant weight, in this case), ideally should come in the first column, although this may have to depend on logic if, for example, the focus is on a derived parameter.

Again, the sequence of the independent variables or rows should be guided by the message you want your readers to pick up from the table. If, for example, you want to highlight those with the highest whole plant weight, you could order the rows from heaviest to lightest (leaving the reference row at the top or the bottom).

Based on these considerations, Table 8.5 could be improved by ordering the rows in descending order of whole plant weight and by removing the columns for parameters that show no significant variation – these can be mentioned in text, with a simple range of values across the treatments (Table 8.7).

Following this approach, Table 8.6 would be rearranged to match Table 8.7. You should keep the same order of rows in the tables, to help readers compare results across the tables (Table 8.8).

These changes both improve the readability of the tables and make them smaller, which simplifies the layout of your final paper in its printed form.

Table 8.6
Biochemical parameters of banana fibre as affected by varietal differences

Parameters	Cultivar						
	Poovan	Karpuravalli	Pachanadan	Saba	Peyan	Robusta	CD at 5%
Total soluble solids (°Brix)	1.87b	1.53[a]	1.93[b]	1.53[a]	1.47[a]	1.27	0.1945
pH	6.650	6.390	6.663	6.447	6.397	0.641	NS
Total acidity (%)	0.025[c]	0.023[b]	0.020[a]	0.031[d]	0.034[e]	0.0294	0.0004
Moisture (%)	95.47[d]	89.13[a]	94.53[c]	93.60[b]	94.80[c]	90.64	0.4618
Total carbohydrate (%)	1.977	2.147	1.910	2.137	2.153	1.089	NS
Total cellulose (%)	3.103[c]	2.77[a,b]	3.193[c]	2.817[b]	2.697[a]	2.690	0.0946
Cellulose content in pure fibre (%)	56.490	55.84	57.89	56.33	56.07	56.34	NS

Note: Across a row, values with the same superscript letter are not significantly different from each other.

Table 8.7
Biomass production and its contributory parameters in different cultivars of banana

Cultivar	Whole plant weight (kg)	Fibre-extractable pseudostem (%)	Fibre yield (%)
Saba	37.63[b]	37.25[b]	0.40[b]
Peyan	37.13[b]	62.29[c]	0.53[c]
Karpuravalli	36.78[b]	29.22[a]	0.26[a]
Pachanadan	25.73[a]	34.29[a,b]	0.88[e]
Poovan	21.83[a]	40.14[b]	0.72[d]
Robusta	19.00[c]	46.23[b]	0.52[c]
CD at 1%	9.3246	10.9030	0.1110

Note: Within a column, values with the same superscript letter are not significantly different from each other (P < 0.01).

Table 8.8
Biochemical parameters of banana fibre
as affected by varietal differences

Cultivars	Total soluble solids (°Brix)	Total acidity (%)	Moisture (%)	Total cellulose (%)
Saba	1.53[a]	0.031[d]	93.60[b]	2.817[b]
Peyan	1.47[a]	0.034[e]	94.80[c]	2.697[a]
Karpuravalli	1.53[a]	0.023[b]	89.13[a]	2.77[a,b]
Pachanadan	1.93[b]	0.020[a]	94.53[c]	3.193[c]
Poovan	1.87[b]	0.025[c]	95.47[d]	3.103[c]
Robusta	1.27	0.029	90.64	2.690
CD at 5%	0.1945	0.0004	0.4618	0.0946

Note: Values with the same superscript letter are
not significantly different from each other.

8.5
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?

"One thing to remember: do not duplicate information across text, tables and graphics"

Anthony Youdeowei

Using illustrations to present research results

9

9.1
Introduction

"One picture is worth more
than ten thousand words"

Chinese proverb, in John Bartlett (1955) *Familiar
Quotations* (13th edn). Little, Brown, New York, USA.

Illustrations 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 called figures) are intended to present data vividly, they must be simple and clear so that readers can immediately understand the message. Illustrations present information in a form that otherwise would need many words.

This chapter suggests some guidelines for making clear and effective illustrations for your scientific papers and reports.

9.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– understand the basic principles of preparing illustrations for scientific papers and reports;
– recognise faults in badly prepared illustrations;
– prepare good illustrations from numerical data.

9.3
Characteristics of good illustrations

Good illustrations should:

– be simple and clear;
– contain relevant legends;
– be independent of the text and of each other;
– be visually appealing, not crowded;
– be organised in the way data are presented.

According to the Council of Biology Editors (1988), illustrations should do the following:

– show the data without distorting what they have to say;
– lead the viewer into the substance of the data with ease;
– encourage comparison of different pieces of data;
– present statistical information in a small space selectively, without being too densely packed (i.e. good composition);
– match the content and style of presentation to the abilities, knowledge and preferences of the target audience;
– take into account the final production/printing process.

9.4
Types of
illustration

Scientific papers commonly use various types of illustration for different purposes.

9.4.1 Line graphs

Line graphs demonstrate relationships among data, or dynamic comparisons. Actual quantities are not marked on line graphs, they tend to be obscure. The type of line graph selected depends on the purpose of the graph and the type of data. An example is shown in Figure 9.1.

Figure 9.1
Rice production and area, Côte d'Ivoire.
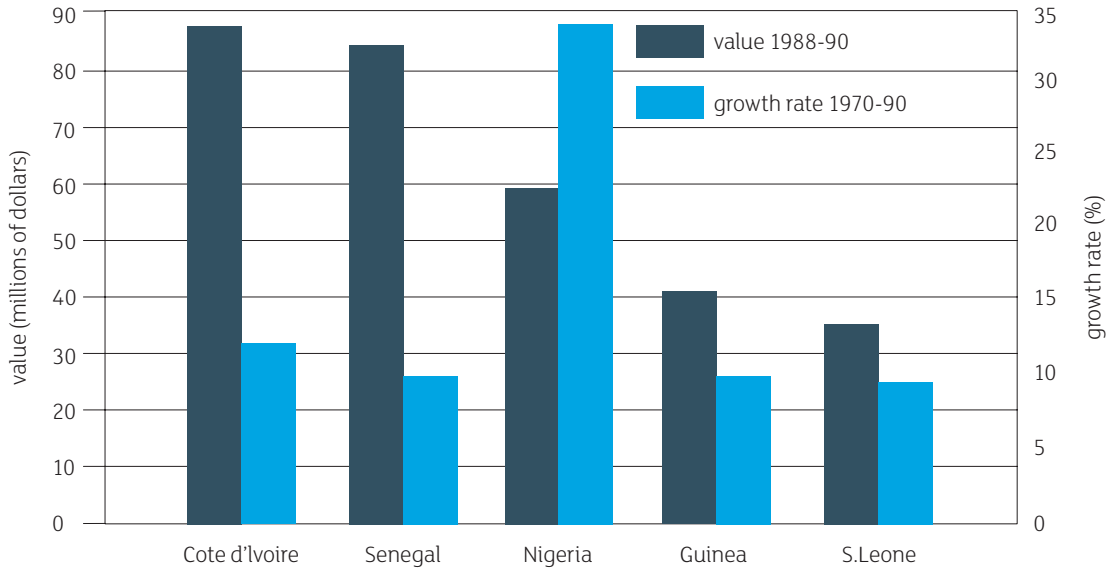**[Line graphs illustrate relationships and make comparisons.]**
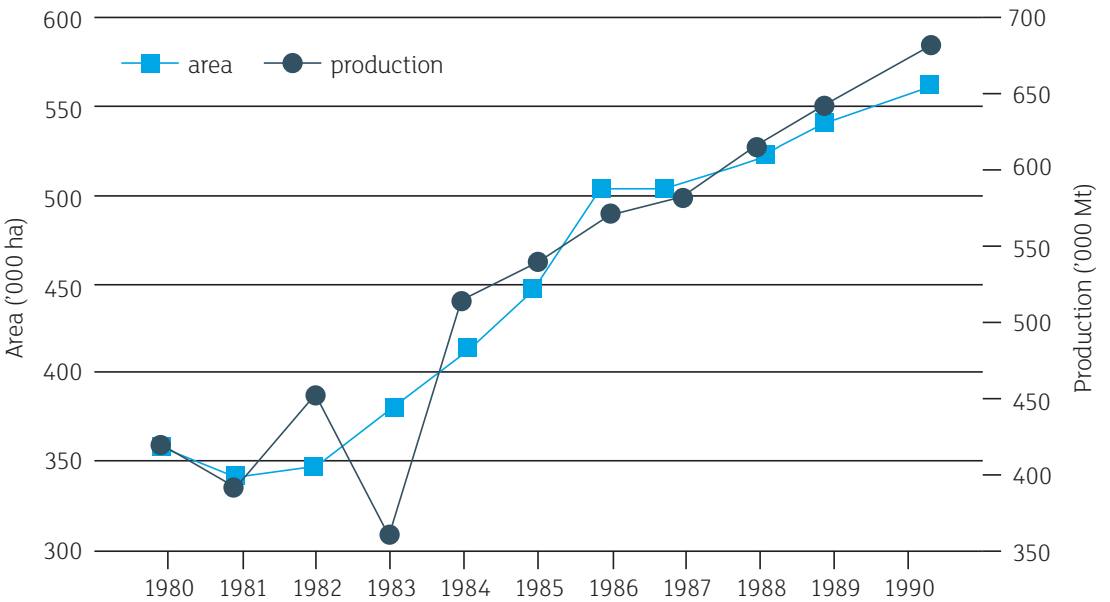
9.4.2 Bar and pictorial graphs (histograms)

These compare qualities, as shown in Figures 9.2 and 9.3.

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 trained by WARDA, 1980–90.
[Pictorial graphs also illustrate comparisons, but care
must be taken not to distort the representations.]

number of trainees   number of courses
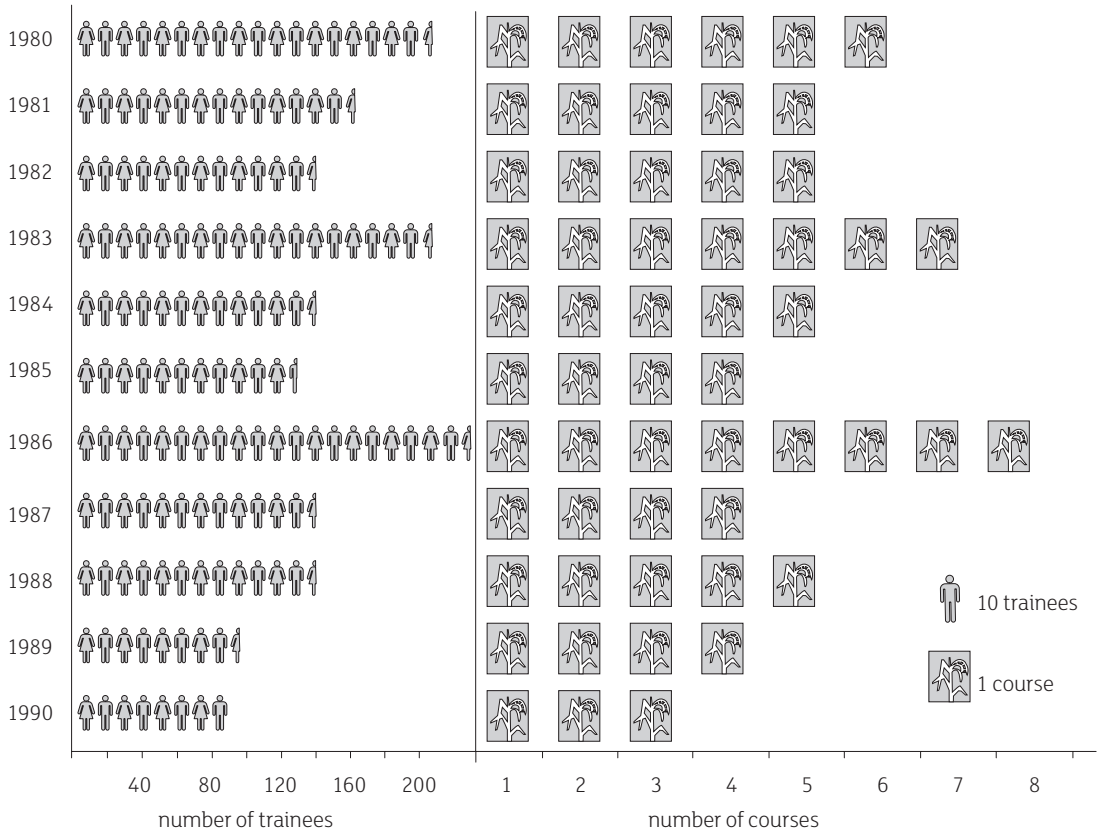
9.4.3 Pie charts

Pie charts are designed to show proportions of a whole (Figure 9.4). They show components as wedges of a circle. A percentage is given for each segment, and the relationships between sections are clear. The percentages total 100.

Figure 9.4
Total rice consumption in Africa, average 1988–90.
[Different forms of pie chart can be used to show proportions.]

Southern Africa
(6.9%)

Eastern Africa
(26.0%)

Central Africa
(6.0%)

Western Africa
(61.1%)
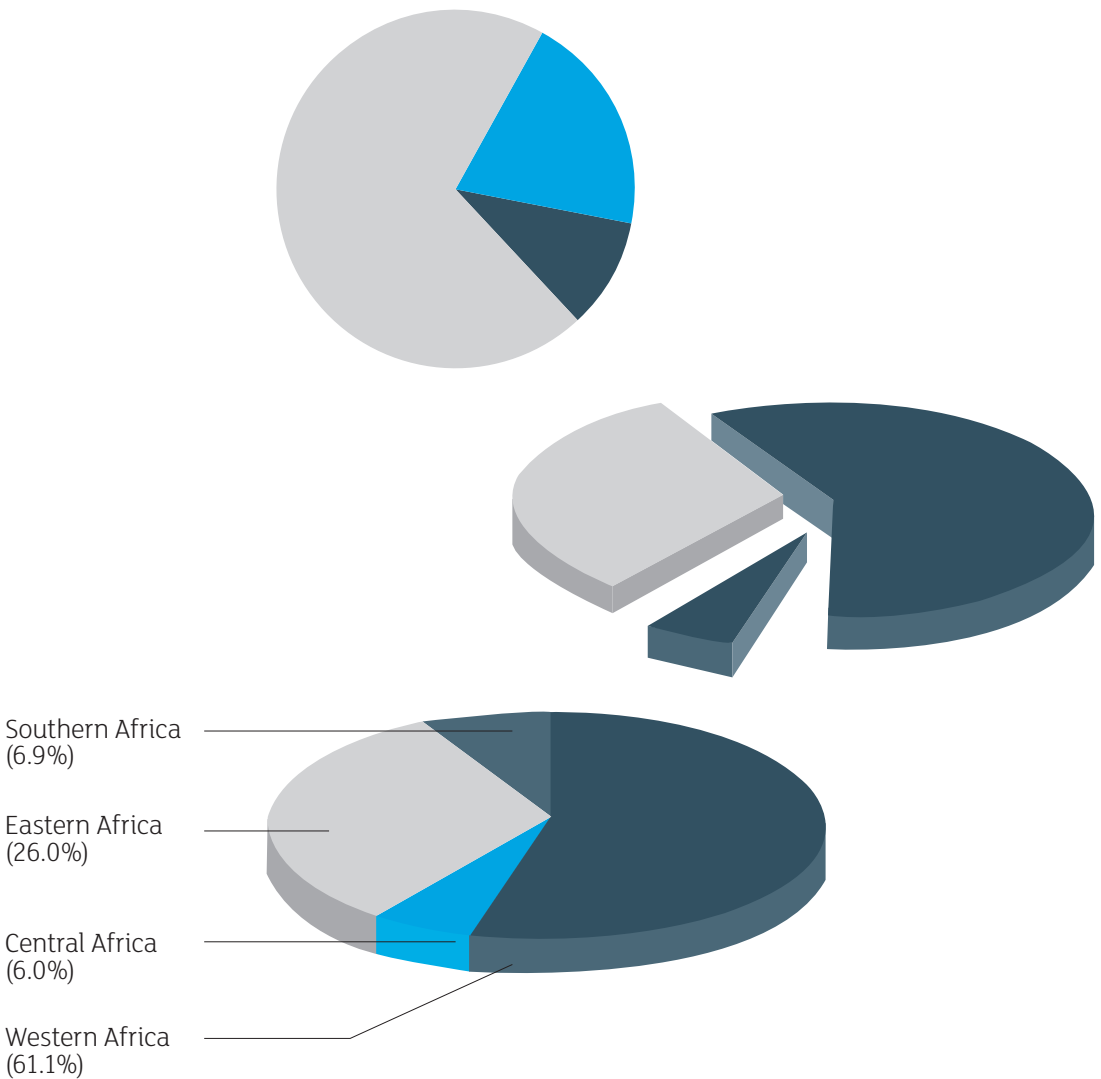
9.4.4 Flow charts

A flow chart shows a process or a complicated system (Figure 9.5). These are used when processes, sequences or systems need to be presented in a successive and organised fashion.

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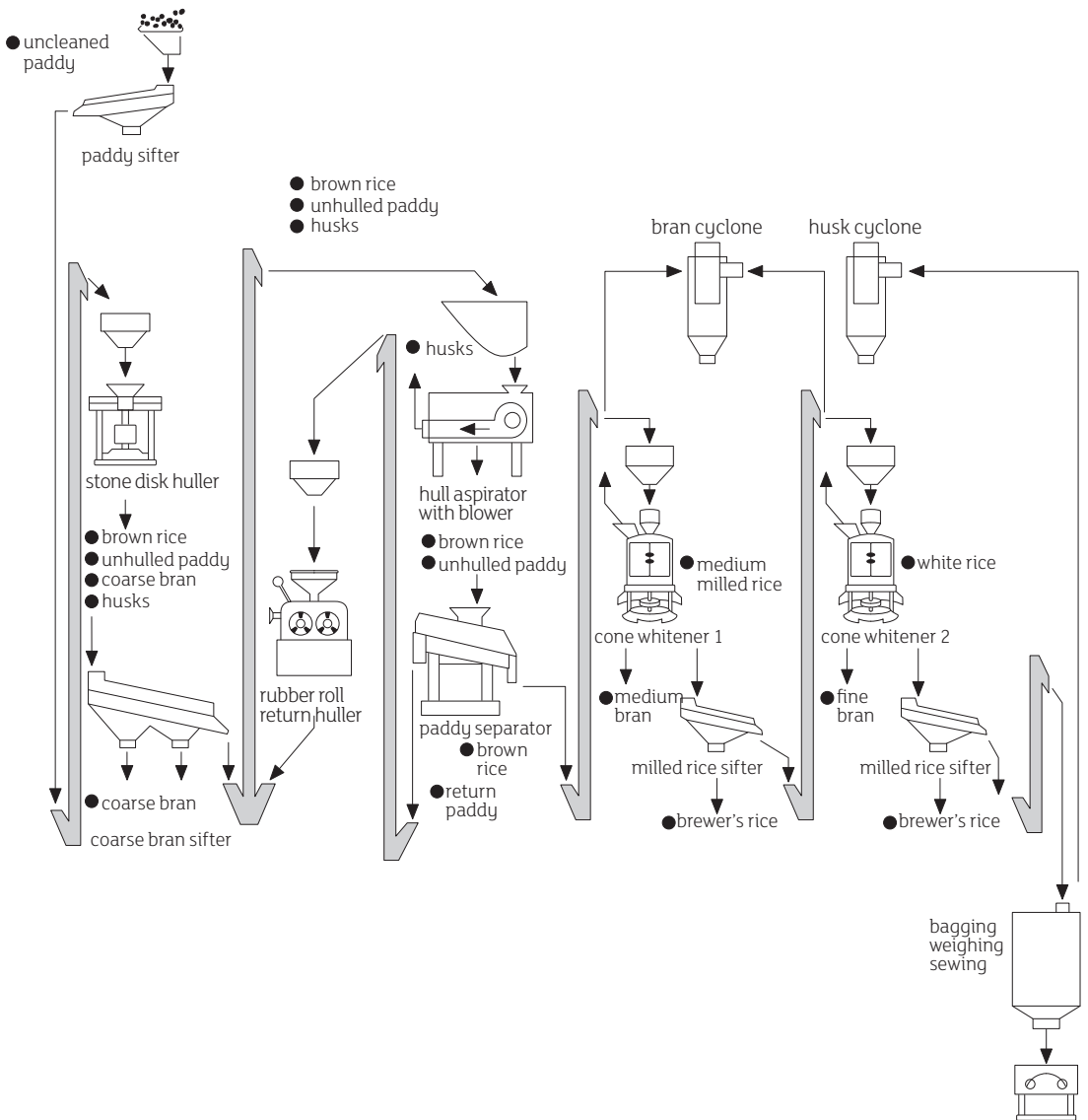
9.4.5 Maps

Maps may be used to show the distribution of quantitative or qualitative data, or to illustrate research sites or other localities (Figures 9.6 and 9.7)

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

Ⓢ *Sahlbergella singularis*

Ⓗ *Helopeltis sp.*
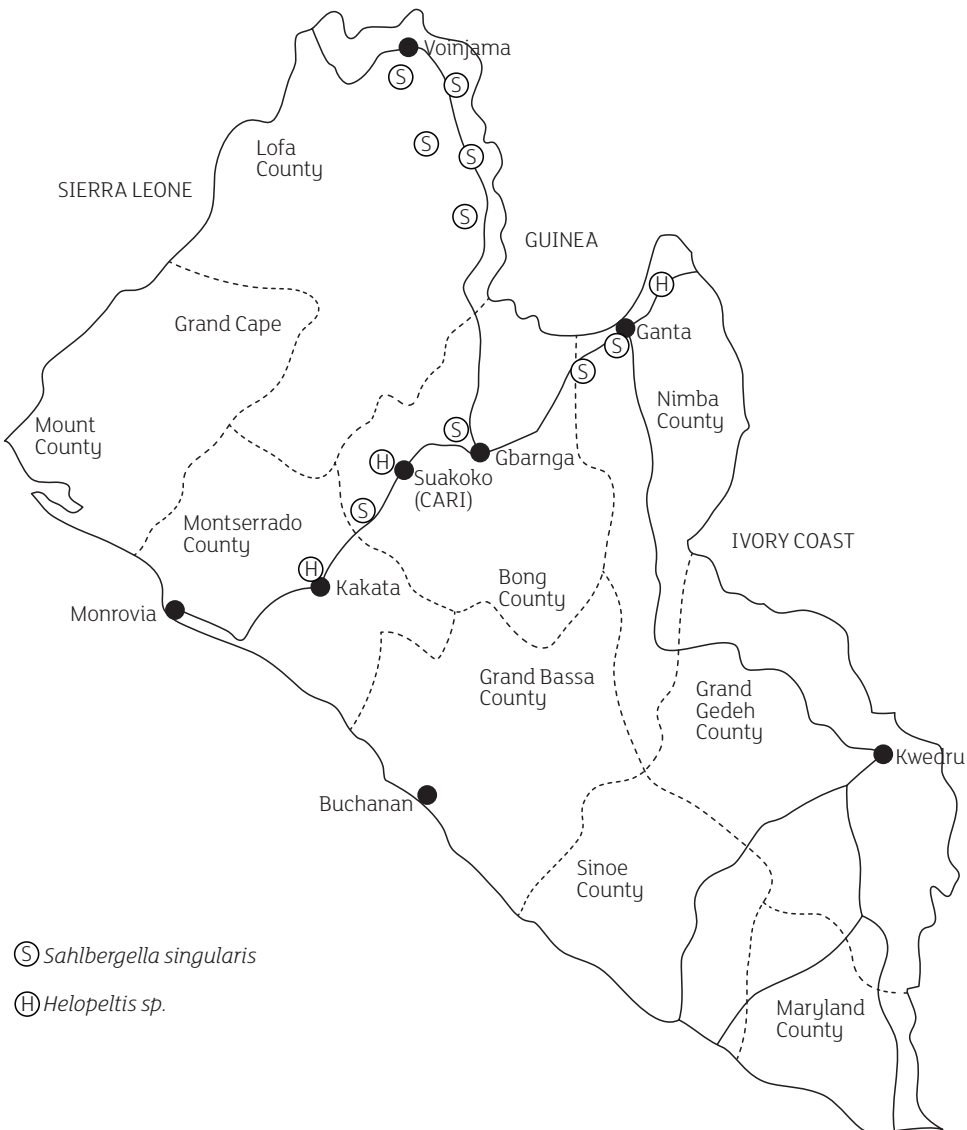
Figure 9.7
WARDA's M'Be site.
[Reference map to illustrate a research site.]
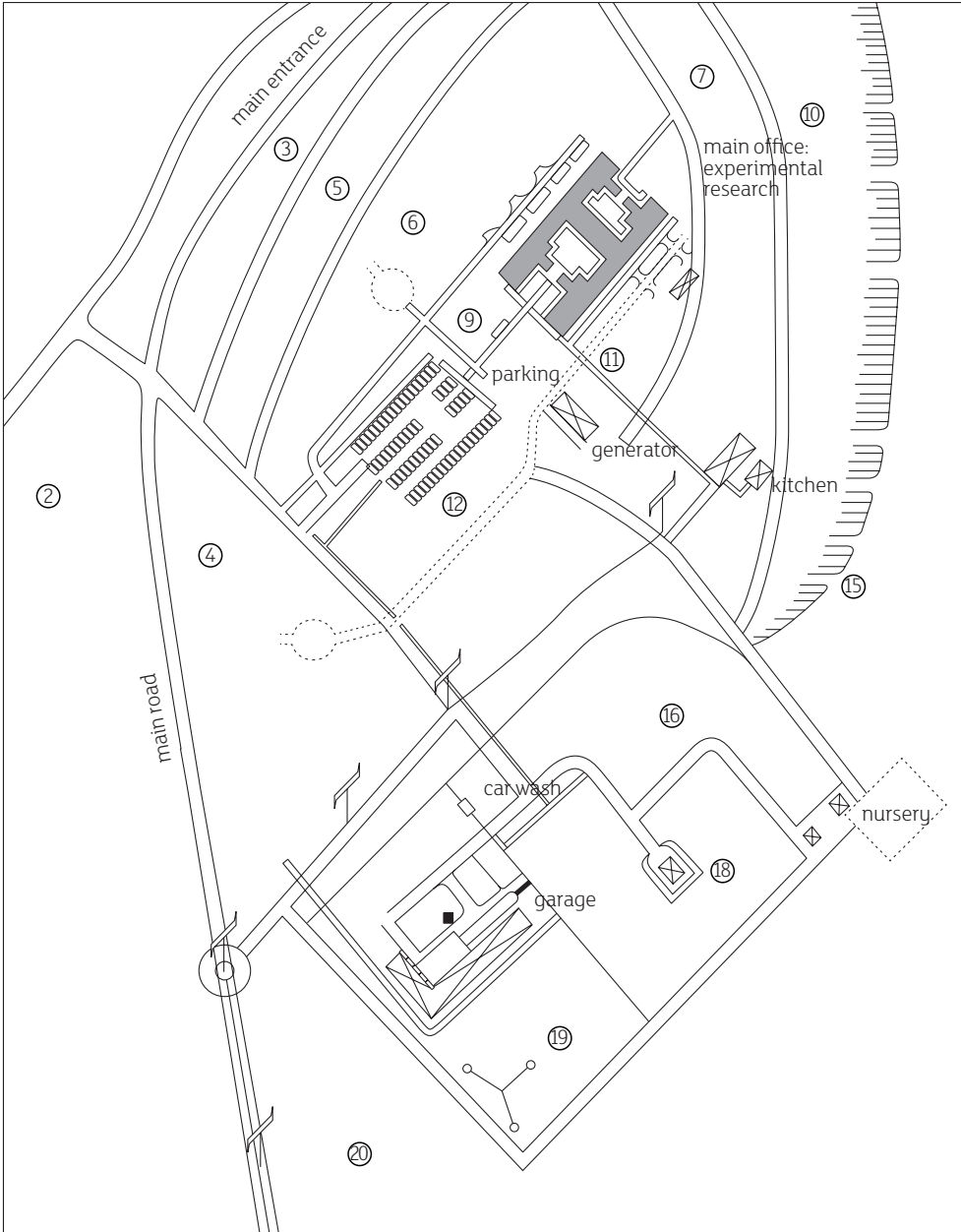
9.4.6 Line drawings

Line drawings are used to illustrate objects or specimens, or to represent data (Figures 9.8 and 9.9).

Figure 9.8
Parts of a grasshopper.
[Line drawings are useful to illustrate specimens ...]
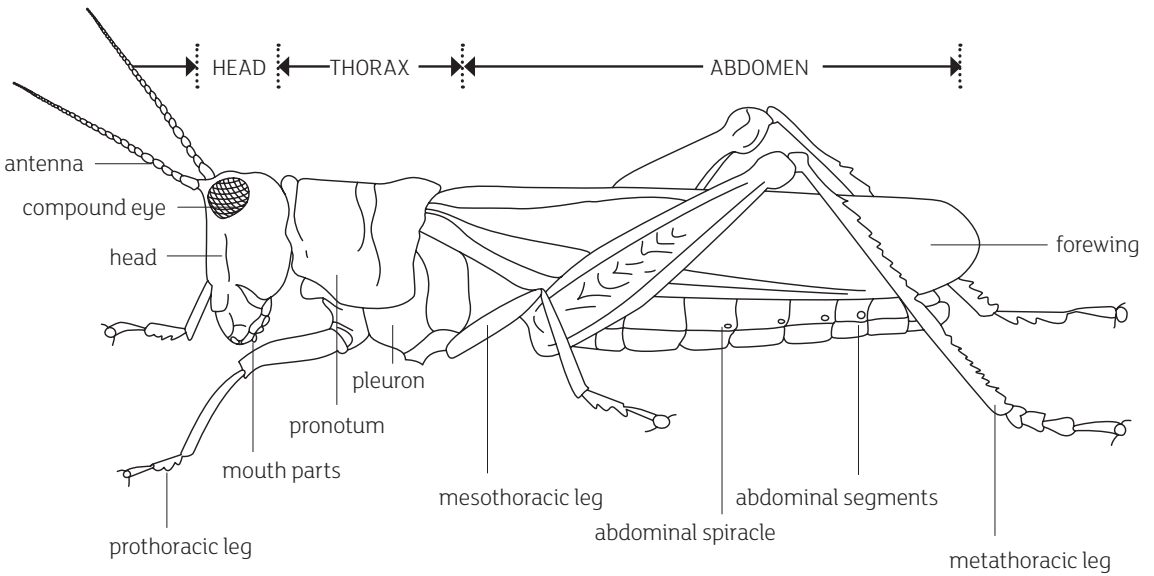
Figure 9.9
Rice plant and detail of section through a node.
[... and can illustrate details that are difficult to show in a photograph.]

leaf blade

leaf sheath

stem (culm)
prophylum

internode

primary tiller
secondary tiller

adventitious roots

internode
leaf sheath

sheath pulvinus
nodal septum
internode

"
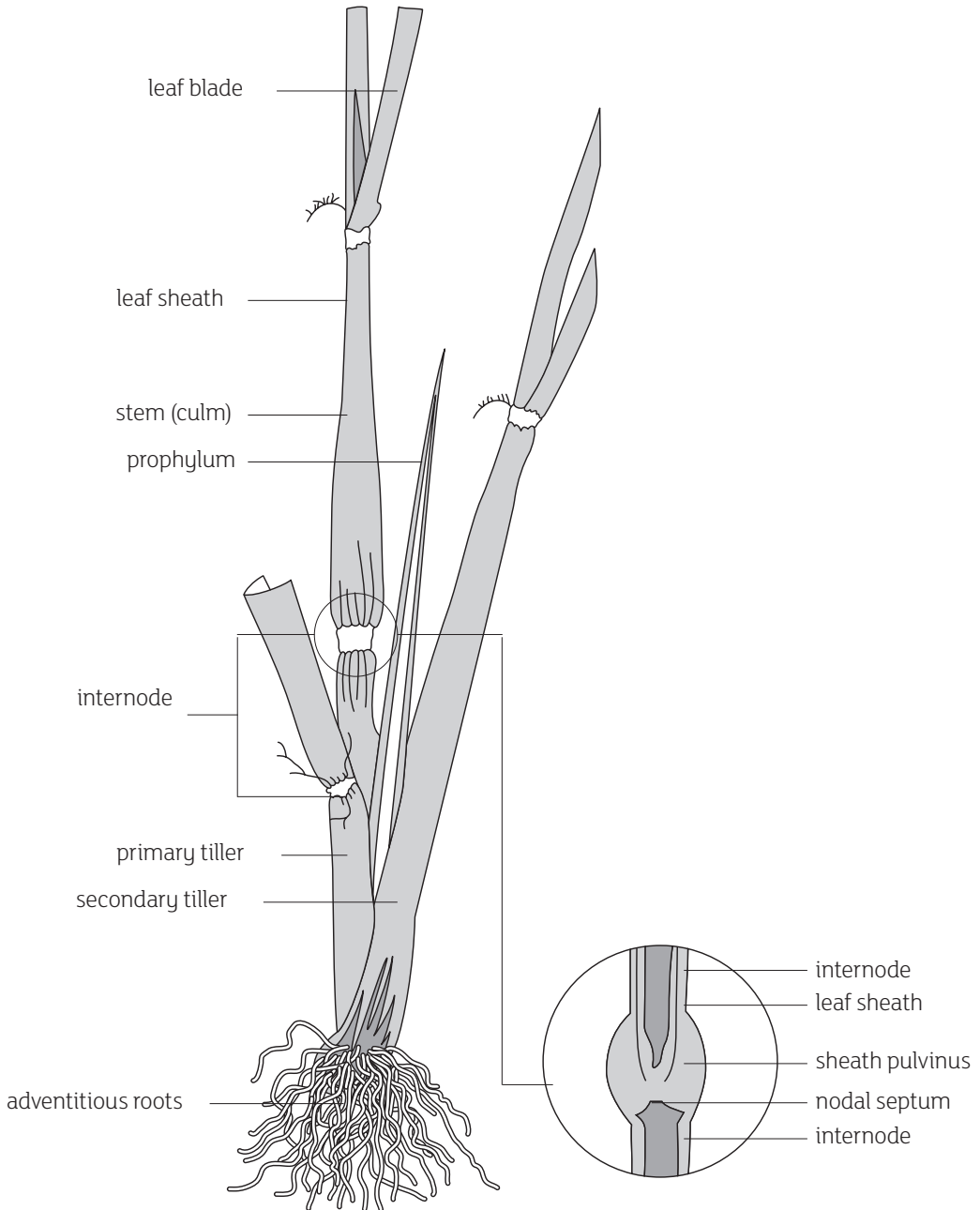
Illustrations present information in a way that is easy to read and understand quickly

"

9.4.7 Photographs

These are accurate representations of objects, taken using a camera. Digital cameras give very sharp, clear pictures which can be printed successfully. The most important aspect of taking pictures is proper composition, so that only the relevant parts of the object being illustrated are shown.

Digital images for publication must be of high quality and have a resolution of at least 300 d.p.i. (colour) and 600 d.p.i. (greyscale). Images should be only minimally processed (for example, to add arrows to a micrograph). The final image must correctly represent the original data and conform to the journal's standards. You should retain your unprocessed digital images, as editors may request them to aid in manuscript evaluation. For one example of detailed instructions regarding submitting digital images to a scientific publication, see www.nature.com/authors/policies/image.html.

9.5
Hints on making illustrations

Producing scientific illustrations is a skilled activity. Scientific illustration is a profession, and people are trained as graphic artists and scientific illustrators. Some institutions have in-house scientific illustrators, and you may be able to seek their assistance with your illustrations.

However, even if you have not been trained as a scientific illustrator, you can still produce good illustrations for your paper. This has been made easier by the use of computer programs such as *Harvard Graphics*, *MS Word* and *MS Excel*. For example, once data have been entered in an Excel file, you can choose the type of illustration needed (pie chart, line graph, histogram) and the program will produce the illustration accurately.

When making illustrations, the most important issue is to decide what is to be illustrated – you need to ask the question "How best can the data or information be presented in a pictorial form?"

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

Line graph	demonstrates the relationships between two data sets or a dynamic comparison over time.
Histogram	shows the frequency distribution of observations for each class of variables, such as weights or crop yields.
Pie chart	compares sizes or proportions of components of a system.
Flow chart	explains a process or system.
Thematic map	shows the pattern of an experimental layout or a geographical map of the distribution of insect pests, for example, over a country or region.
Line drawings	illustrate objects or present numerical data.
Photographs	show the actual appearance of a specimen or something you wish to describe.

Make your figures simple enough so that the reader can understand the message instantly. A figure that tries to show too many things usually ends up not showing anything clearly. The figure you submit for publication should be drawn and lettered neatly as it may not be redrawn for publication.

9.6 Points to remember

Journals provide guidelines on how to present illustrations. Usually it is best to submit each figure on a separate page with appropriate legends; the editor will incorporate each figure into the text in the most appropriate place on the page of the journal.

Letter sizes, fonts and styles are used to ensure information stands out – follow the importance of the information. Axis labels should be the largest and boldest letters on the figure. For maximum legibility, keep labels in upper and lower case, in a sans serif typeface of medium weight. Units of measurement should be given in parentheses in lower case letters: (°C).

Artwork should be larger rather than smaller than the finished print size.

Illustrations should be simple enough to convey the message with ease.

Originals should be clear and sharp.

Scanned images should reproduce easily and clearly.

9.7 References

Council of Biology Editors (1988) *Illustrating Science: Standards for Publication*. Scientific Illustration Committee of the Council of Biology Editors, Chicago, IL, USA.

" Illustrations provide information in a form that otherwise would need many words "

Roger Stern

Reporting statistical results in a research paper

10

10.1
Introduction

The findings of your investigation should be reported in the Results section of a scientific paper. Here we assume that you have already written the earlier sections of your report, have done part of the analysis, and have produced provisional tables (Chapter 8) and graphs (Chapter 9).

You are nearing the end of your research road. Just like building a real road, this should be an exciting stage because the end is in sight. It is also a vital stage. A research grant or other support for your work has been given in good faith, and respondents and collaborators have given their time, on the assumption that the research gap needed to be filled. If no report or paper is produced, it is like taking funds to build a road and squandering them, so there is no road. If the report is done only sketchily, it is like building a substandard road that will soon need further work because it is not fit for purpose.

Many people feel strongly that taking money to build a road and then squandering the funds, so there is no long-lasting road, is a clear case of corruption. Taking funds for research and failing to report the results is the same.

10.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

complete the analysis necessary to report your research results in scientific papers.

10.3
Describe the statistical method

It is usually necessary to include a description of the statistical methods that have been used. This is so that readers can see that the methods are appropriate, and so the analyses could be repeated later if necessary. In simple cases a clear description can be given briefly, as in Box 10.1.

Box 10.1 A description of an analysis

The average soil nitrate was calculated from the 10 samples in each plot. Logs of the plot means were taken to stabilise the variance, before calculating an analysis of variance, based on the randomised block design.

In other cases it can be difficult to be brief, because the analysis involved many steps or was otherwise non-standard. There then has to be a compromise between an incomplete and a detailed description. You must be clear about any data that were omitted from the analysis, and the reasons for the omission. It is usual to name and give a reference for the statistical software that was used. If the analysis was particularly complex or novel, it may be appropriate to give the software commands that were used. These may be in an appendix to the paper, or on a website.

The study you have undertaken was to fill a knowledge gap. This gap was described in the Introduction of your paper or report. It led to the specification of the study, which has been described in the Methods section. Now you are ready to report on how the results of your study have filled this gap, or at least provided evidence to help to fill it.

Your results may reinforce, or they may contradict, results from previous studies that have been reported in the literature. When the comparison is simple, it may be mentioned briefly in the results section, for example:

"The results in Table 7 confirm those in Youdeowei *et al.* (2002), and show that variety xxx gave the highest yields, except in 1999, which was an exceptionally dry year."

Usually comparisons are not so simple: there may be caveats because of the different years, sites, sampling schemes, etc. In that case, comparisons with previous work should be left to the Conclusions section of your paper, because these caveats will distract the reader from the evidence provided by your study.

You are writing a scientific paper, so you must report the evidence that can be drawn from your study in an objective way. In the conclusion to the paper, you may also wish to add your personal views. This is permissible, but you must distinguish between the evidence from the study and your personal views. Avoid letting your personal views bias the tables, graphs and reporting of the study.

10.4
Why might effective reporting of the results be difficult?

If research is well planned and executed, and is solving a real problem, the report is usually easy to write. If not, difficulties are often resolved by reviewing the research as a whole. Common reasons for difficulties include the following.

10.4.1 The research objectives were not clearly specified

The case for the research, or the research objectives, may not have been specified sufficiently clearly. A clear specification should have implied the measurements to be taken, the treatments to be applied, and so on. Box 10.2 gives an example where the routine measurements taken were not related to the objectives.

Box 10.2 Dealing with a measurement that cannot be reported easily

In a study on maize, the most time-consuming task was measuring the height of the plants. This was done on 10 plants, randomly selected in each plot. The team knew how to do the analysis, but reporting the results did not satisfy the "so what?" test. It merely confirmed that some maize varieties were taller than others, which was already well known from early breeding trials on the same varieties. Examining the knowledge gaps and the objectives showed that they did not relate to plant height. Furthermore, the research team could not think of any further useful objectives that could be added at the analysis stage, that would use the measurement of heights.

Further discussion showed that tradition (we always measure plant height), rather than the objectives, had dictated the measurements to be made.

The solution was to omit any reporting of plant height in this study, and also to save funds in future studies by measuring only the variables that could be justified by the objectives.

10.4.2 An inappropriate methodology was used for the research

The example in Box 10.3 shows the use of an inappropriate methodology for the objectives that were specified. This was an extreme case; more commonly the objectives may have to be modified once the data are available. There may be four objectives, and you now realise that one of them is unattainable, given the data.

Box 10.3 Choosing the appropriate approach

A cotton-production group demanded research from the National Agricultural Research System cotton specialist. They reported that they currently planted their cotton earlier than before because of climate change. However, sometimes early planting had led to problems when the cotton was ready for harvest but the rains were still continuing. They required information on the optimal planting date.

The researcher felt that this problem demanded the use of long-term climatic records, which he obtained from the National Meteorological Service. But he was trained as an experimenter, and did not know how to process the climate data. He therefore designed an experiment with a single treatment factor of planting date, at six levels. This was conducted for 3 years and analysed with the usual analysis of variance (ANOVA). He was now ready to write the report and present the results.

The report showed only that the optimal date was different each year – a fact already well known by the cotton group. Looking back at the objectives, the researcher had been correct in obtaining the historical climate data, but not in doing the single-factor experiment.

10.4.3 The data collection had bad luck or was not undertaken well

Perhaps the study was on diseases or pests in years when they do not occur; or on different varieties in years when a pest is prevalent. A survey may suffer from a very low response rate, or from questions being understood differently by different groups.

Often the difficulties can be resolved partially by modifying the objectives. Some of the objectives may no longer be realisable, but the difficulties may also permit a new objective to be added.

In extreme cases, the objectives simply cannot be realised. Then a report may have to be changed substantially, for example, it might assess whether the methodology that was adopted should be avoided in future years. The report becomes effectively one of a pilot study that recommends the ways for further action, if any.

10.4.4 An out-of-date approach to data analysis was used

Sometimes the analysis is separated from the report writing. A junior staff member may be asked to "do" the analysis, and the results are then used by a more senior researcher to write the report.

This separation of analysis and reporting was used more commonly before the advent of computers and statistical software encouraged an interactive approach to data analysis. It is not to be encouraged, because it misses the opportunity to adapt the analysis as the first results become available. The analysis is part of your "voyage

of discovery", which is unlikely to be a very productive voyage if it is specified completely, before seeing the first results.

A few staff still restrict the methods of analysis they use to those they were taught as students. Statistical methods have advanced substantially in the past decades, while the limited methods taught earlier concentrated unduly on significance testing, the normal distribution and so on.

10.5
What should
be reported?

The role of statistics in your paper or report is to provide the numerical evidence to support the arguments being made. Your detailed results probably have produced numerous tables of means, standard errors, coefficients of variance, analysis of variance tables, regression results, r values, and so on. You now have to sift through these results so you can justify why you are reaching the conclusions in your paper. Do not present results just because you have calculated them.

The role of measures of precision (such as standard errors) is to quantify the uncertainty in other numbers, perhaps treatment means. This uncertainty is important because it shows how much confidence can be placed in the other numbers, and hence how firm or clear the conclusions are. Thus these measures of precision are part of the essential information that supports the conclusions, and should be included.

It is necessary to discuss statistical results in the text, but you should avoid repeating lists of results that can be see more clearly in the tables or graphs. However, some results from each table or graph must appear in the text, otherwise that table or graph can probably be omitted.

In describing the results from a table or graph, avoid long lists of "effects that are significant". It is common to find strings of sentences (see Box 10.4) that just repeat items that can seen more clearly in the corresponding table. Instead, the text should draw attention to the important patterns that will later be interpreted (bottom of Box 10.4).

Box 10.4 Reporting results from a table in the text

Avoid sentences such as:

"Soil nitrate was significantly different ($P < 0.05$) between treatments in all seasons, except 1997, when it was nearly significant ($P = 0.07$). Soil ammonia-N was significantly different in the first two seasons, but not in 1997 or 1998."

Instead, consider something like:

"Soil nitrate and ammonia-N were clearly higher in agroforestry plots than the control, in all years except the driest, when the difference was only half that seen in normal years."

10.6
The term "significant" is overused in papers and reports.

– "Significant" has a different everyday use from the statistical use, and some readers may be confused. "Significant" in general use is roughly a synonym for "important", whereas a result that is statistically significant may be of no practical importance.

– There is no clear boundary between "significant" and "not significant". The use of 5% and 1% was a convenience in the pre-computer age, when tables could be prepared for only a few probability levels. Instead, phrases such as "clear evidence for…", "some evidence for…", or "little reason to believe that…" enable the current state of your knowledge to be presented more informatively.

– Results that are "not significant" are sometimes misinterpreted as not being present. A result may exist and be of practical importance, and at the same time be non-significant. This is usually when a study is small or the data are very variable.

The significance testing approach is sometimes overused. Many study objectives need estimates not just of whether a treatment difference exists, but of whether the difference is large enough to be useful in some way. It is often more appropriate to give estimates of the size of an effect (e.g. with a confidence interval) than to present statements about significance.

The coefficient of variation (cv) is an over-reported summary statistic. It is the residual variation of the data as a percentage of the mean. It makes sense only for variables that are positive, and where the average is meaningful, such as yields; it would not make sense for disease score on a 1–9 scale because it could equally be 0–8, or for temperatures because negative values are possible. The main reason for rationing its use is that the cv is rarely related to the objectives of a study. A low value is usually an indication that an experiment was well conducted. If it is to be discussed, it should be when other aspects of data quality are being considered, such as outliers or missing values.

In many studies, the analysis does not finish with conclusions based on a simple analysis of the data. The real objectives of the analysis are met only when the results are used in further analysis. This can take many forms, for example a farm-level financial analysis; a comparison of the results with those from a simulation model; the estimated impact of adoption of the recommended treatment on productivity in the region; or the mapping of potential adoption domains. For example, the measure of precision (standard error) of the benefit of a new treatment compared with the standard is needed (and often ignored) when estimating the financial return on its adoption. What is new is that these further analyses usually combine information from the current study with information from further sources.

10.7
Reporting when there is a single factor

The tables in Chapter 8 are from a study on a single factor, so the structure of the tables is simple. A revised version of Table 8.7 is given in Table 10.1.

Table 10.1
Biomass production and its contributory parameters in different cultivars of banana

Cultivar	Genomic status	Whole plant weight (kg)	Fibre-extractable pseudostem (%)	Fibre yield (%)
Saba	ABB	37.6	37.2	0.40
Peyan	ABB	37.1	62.3	0.53
Karpuravalli	ABB	36.8	29.2	0.26
Pachanadan	AAB	25.7	34.3	0.88
Poovan	AAB	21.8	40.1	0.72
Robusta	AAA	19.0	46.2	0.52
CD at 1%		9.3	10.9	0.11

The objectives of this study can be deduced partly from a section in its introduction titled "genomic status and fibre yield". The first table in the paper gives the genomic status of each of the six cultivars, and the results are periodically related to this status. This indicates that the varieties were used, slightly in their own right, but particularly to represent the different genomic status.

Unfortunately, it does not appear that the genomic status was used in the analysis. This is perhaps because only simple statistical software was used, but also perhaps because the analysis was distracted by the multiple comparison tests that were in the original tables (Chapter 8).

Multiple comparison tests are an overused and misused tool. They are misused when the structure implies particular ordering of the levels, such as fertiliser amount, which is quantitative. In analysing experimental data, the only commonly used factor where the tests can be justified is variety. Hence it is not misuse to consider varieties in the example above. Even in this case, there are two reasons for avoiding multiple comparison tests, as follows.

– The objectives of a study are only rarely met by doing significance tests. These tests are usually appropriate only at the start of the analysis. Further analyses move from the testing phase to estimating the size of an effect, in ways that correspond to the objectives.

– The logic of multiple comparison tests, though correct, often distracts the analyst from conducting a more perceptive summary of their data, even within the testing framework.

In the example above, take the key variable of whole plant weight, used to order the varieties in the table. When considered in relation to genomic status, the weights appear to divide into three groups with the different genomic status. An obvious question is whether there is any detectable variation in plant weight between the varieties within each group, or does the evidence show that the variation can all be explained by the genomic group? In the report, the table could still be given as above, but the text should report the results of this additional test.

There was clear structure in the six varieties that were used. This genomic structure was discussed at length in the justification for the research, but it was then ignored in the analysis. In this example, the scientists were distracted by the lure of multiple comparison tests that bore no relation to the objectives of the study.

Table 8.8 omitted the variables that were not significant from the original table. This was correct because these variables could then be discussed briefly in the text. However, with the additional genomic structure considered, Table 10.2 above reinserts two of the variables: pH and total carbohydrate (%). Although, ignoring genomic structure, there was no significant difference in the carbohydrate percentage, it is perhaps of interest to note that the three ABB varieties had a mean around 2.15%, compared with around 1.95% for the AAB varieties and 1.1% for the AAA control. It is quite possible also that this genomic status (with 2 degrees of freedom, df) is statistically significant, while the overall variety effect (with 5 df) is not statistically significant, because the varieties within each genomic status have added "noise" to the data.

Table 10.2
Biochemical parameters of banana fibre
as affected by varietal differences

Cultivars	Total soluble solids (°Brix)	pH	Total carbohydrate (%)	Total acidity (%)	Moisture (%)	Total cellulose (%)
Saba	1.53	6.45	2.14	0.031	93.6	2.82
Peyan	1.47	6.40	2.15	0.034	94.8	2.70
Karpuravalli	1.53	6.39	2.15	0.023	89.1	2.77
Pachanadan	1.93	6.66	1.91	0.020	94.5	3.19
Poovan	1.87	6.65	1.98	0.025	95.5	3.10
Robusta	1.27	6.41	1.09	0.029	90.6	2.69
CD at 5%	0.20	NS	NS	0.0004	0.46	0.095

In Table 10.2, the reader could learn more if the significant (or critical) difference was given, even if the result is not significant. This could be given together with the NS. Preferably, there would be an extra row in Tables 10.1 and 10.2 that gives the exact significance level. All that is known in Table 10.2 is that pH and carbohydrate has a significance level greater than 5%. The report might be different if the significance level is 6% or 60%.

Finally, it is usual to use the same level of significance for all tables, unless there is a good reason otherwise. No reason was given in this paper. With all the improvements that have been suggested for this short paper, the refereeing process is questionable, as well as the statistical support available to the authors.

10.8 More than one factor

Most studies have multiple factors. The ANOVA then dictates how complicated the tables and graphs need to be. Table 10.3 is taken from Stern *et al.* (2004), where there is no interaction between two treatment factors.

When there is an interaction that is statistically significant but of relatively minor importance, the results could still be presented as shown in Table 10.3, but with an extra row giving the F-test probability for the interaction. The explanation of the interaction should then be explained briefly in the text.

When there is an interaction, the results for a single variable may be reported in a two-way table. A skeleton table for more than one variable is shown in Table 10.4.

" The role of statistics in your paper or report is to provide the numerical evidence to support the arguments being made "

Table 10.3
Skeleton results for a hypothetical lamb nutrition experiment with three levels of supplement and two levels of parasite control (no interaction)

Factor	Final live weight (kg)	Weight gain 0–120 days (g/day	Age at puberty (days)
Supplement	–	–	–
None	–	–	–
Medium	–	–	–
High	–	–	–
SED	–	–	–
Parasite control	–	–	–
None	–	–	–
Drenched	–	–	–
SED	–	–	–
F-test probability	–	–	–
Supplement	–	–	–
Parasite control	–	–	–

SED = standard error of difference.

10.9
Reporting results from participatory studies

Many research studies now include a participatory component. The level at which data are collected may be a focus group rather than a household or a plot of land. We assume the sample size (in this case, the number of focus groups) is large enough for the work to be reported in a statistical way, rather than being anecdotal (see Barahona and Levy 2003). Much of the reporting of results can be in simple tables and graphs, usually after coding the information.

In addition, most participatory studies also have insightful individual contributions. These can usually be reported in the text, or in separate boxes, taking care that they illustrate valid points in a way that does not mislead readers. Examples from the education section of a study in 36 villages in Uganda are given in Boxes 10.5 to 10.7 (from UBOS 2006).

Box 10.5 Value of education

The study found that in rural areas most parents valued education, agreeing that it contributes to individual and collective wellbeing of both family and community. For example:

"There is nothing better a parent can give a child than seeing a child through school."

(Elderly man, Kirimamboga, Wakiso).

Longer stories can be in a box within the text, for example:

Box 10.6 Case study: The importance of education

"I am a widow. I have no means of subsistence and I am a squatter on church land. My eldest daughter is 14 years of age; she is in Primary Six but she is in and out of school due to lack of money to pay school dues. My second and third daughters have had to drop out because we can't afford to pay. I took them out of school so that I could pay for the one in Primary Six.

The children are losing so much by not going to school. An illiterate person who does not know how to read and write is hopeless. For girls it is worse. You find those near town engaging in prostitution as young as 12 years old. The government should make efforts to make sure that all school-age children can remain in school. Although UPE has helped, books, pencils and other things are not easy for us to afford. As a parent, I am at a loss."

(Parent, Kabwohe Hill, Bushenyi)

Table 10.4 Skeleton results table for a hypothetical lamb nutrition experiment with three levels of supplement and two levels of parasite control, with interaction

Supplement	Parasite control	Final live weight (kg)	Weight gain 0–120 days (g/day)	Age at puberty (days)
None	None	–	–	–
	Drenched	–	–	–
Medium	None	–	–	–
	Drenched	–	–	–
High	None	–	–	–
	Drenched	–	–	–
SED		–	–	–
F-test probability		–	–	–
Supplement (S)		–	–	–
Parasite control (P)		–	–	–
Interaction (S × P)		–	–	–

SED = standard error of difference.

In the section on coping mechanisms the following quote is particularly moving in its implications:

Box 10.7 Raising money for medical treatment

Sale of assets to raise money for medical treatment in case of sickness was reported as a significant coping mechanism:

"My husband sold his bicycle to get money to take me to Kanyeganyege clinic, where I got treatment and recovered."

(Woman, Kyesika, Bushenyi)

10.10 Finally

In this chapter we have concentrated on the presentation of results, in the text and in tables. This is not to negate the importance of charts (see Chapter 9), but generally more attention has been given to graphs. It is through the appropriate use of all methods that results can be presented in ways that are fair and informative, as well as being eye-catching and clear.

10.11 References

Barahona, C. and Levy, S. 2003. *How to Generate Statistics and Influence Policy using Participatory Methods in Research: Reflections on Work in Malawi 1999–2002*. IDS Working Paper 212. Institute of Development Studies, Brighton, UK.

Stern, R.D., Coe, R., Allan, E.F. and Dale, I.C. (eds) (2004) *Good Statistical Practices for Natural Resources Research*. CABI Publishing, Wallingford, UK.

UBOS (2006) *Uganda National Household Report 2005/6: Qualitative Module Report*. Uganda Bureau of Statistics, Kampala.

Anthony Youdeowei

Oral presentation of research results

11

11.1
What is oral presentation?

Oral presentation of research results is a major method of communicating the results of a research endeavour. This pattern is commonly adopted in institutional seminars, international conferences, workshops and training courses. Oral presentation is important for effective communication of research results, and improved presentation skills result in more effective communication. Agricultural research scientists, as well as other practising researchers, need to develop good presentation skills.

Oral presentation:

– is an opportunity for the audience to see, listen to and hear the speaker;
– gives the audience only a limited time in which to hear and understand the speaker;
– uses visuals to enhance the communication process;
– offers the opportunity for two-way interaction between speaker and listeners to facilitate communication.

This chapter provides some guidelines for the effective oral presentation of research results.

11.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

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

11.3
Characteristics of oral and written presentations

There are major differences between a scientific paper written for reading and a paper written to be presented at a scientific meeting. A scientist reading a written paper has the luxury of lingering over the text to absorb and understand the contents, even going back to a previous paragraph to help grasp the significance of something later in the text. But in an oral presentation, the listeners may have only one chance to understand the material being presented, so the speaker needs to present each idea clearly – and perhaps even repeat key points and ideas.

Research has shown that in oral presentation, it takes an average of 3 minutes to put across a new idea, so the speaker must repeat and expand on an idea several times for the audience to get the message. In most scientific meetings, each speaker (except the keynote or specially invited speakers) is normally allowed only about 15 minutes. The speaker should allow 2 minutes for presenting the introduction and 1 minute for the conclusion. This leaves about 12 minutes for the presentation of the actual research results. This suggested pattern is:

– Introduction – 2 minutes;
– The facts – 12 minutes;
– Conclusion – 1 minute.

This is a very short time in which to present research results that probably took several months, seasons or years to complete. This is not an easy task, and scientists who wish to present their research results at scientific meetings should make the time to prepare adequately for the event.

11.4
Key considerations

A few key issues should be considered in the process of preparing oral presentations.

First: decide on the purpose of the presentation. The primary purpose of making the scientific presentation is to inform your audience about the results of your research work. It could also include persuading your listeners to accept your ideas and take appropriate actions, especially when specific recommendations are made in your presentation – or even to entertain your audience.

Following consideration of the purpose of the presentation, other key considerations include the following.

Characterise your audience – who are they? Is the audience a group of persons with mixed technical and social backgrounds; or a homogeneous or clearly defined group of specialists, for example entomologists or plant protection specialists? And what are the interests of your audience?

What is the objective of your presentation? What do you wish to achieve through it?

Here are a few hints about how to prepare and deliver an oral presentation at a scientific meeting.

11.5
The process

The process for preparing and making oral presentations of research results has the following components: preparation actions; pre-presentation review; and the actual presentation or delivery.

11.5.1 Preparation

Adequate preparation is required to make successful oral presentations. Remember to pay attention to the following issues.

– Always prepare your presentation carefully.

– Decide on the specific topic of the presentation – make it simple and clear. Cover a limited number of ideas, for example two or three only.

– Find out how much time is allowed for the presentation – in conferences, usually 15 minutes maximum.

At normal speed, speakers generally deliver about 400 words in 5 minutes. This is about 2 to 2.5 double-spaced, typewritten A4 pages. Therefore, for a 15-minute presentation, your paper should not exceed 10 double-spaced, typewritten A4 pages, including the illustrative matter. The text should contain only your main ideas. Avoid citing references and acknowledgements – these will waste your precious presentation time.

– Write your presentation fully. Revise and edit it to improve the technical accuracy and language.

– Make it precise and logical.

– Make it interesting.

– Focus on the major ideas – there is no time for extras.

"

Agricultural research scientists, as well as other practising researchers, need to develop good presentation skills

"

After writing your presentation, carefully use the text to prepare the PowerPoint presentation slides. Prepare or select your illustrative matter such as PowerPoint slides carefully. Ensure all the illustrations are relevant to the subject and reinforce what you say.

– Do not crowd too much data into the visual materials.

– Double-space the text and/or use large letters so that the text is easy to read.

– In your presentation text, mark the exact spots where visuals will be presented.

– Organise your illustrations in the sequential order that you intend to use them, and number them serially.

– Rehearse your presentation with a colleague so that you know it fits into the time allocated.

– Anticipate questions and prepare short answers.

Dress neatly and well, and avoid flamboyant or outrageous dress that will attract undue attention.

11.5.2 Pre-presentation review

Before actually making your presentation, it is useful to review the facilities available in the conference room.

These days, most presentations are made as PowerPoint slides, therefore you should develop skills in the design of effective PowerPoint presentations.

– A few minutes before the scheduled time of your presentation, usually during the preceding coffee or lunch break, load your PowerPoint slides onto the presentation computer.

– Test-run the presentation to ensure the sequence of slides is correct and that the projection on the screen is clear and straight.

– Review the text and visuals to ensure they match.

– Familiarise yourself with the sitting pattern of the audience and the type and location of the microphone – is it hand-held, or attached to your coat lapel of shirt collar?

– Familiarise yourself with the remote control mechanism if one is in use in the conference room.

– Review the mechanism for pointing at the screen during presentation to emphasise specific points. The mechanism may be a torch pointer or a rod pointer. It is strongly advisable always to have your own torch pointer whenever you are making a presentation at a scientific meeting.

11.5.3 During the presentation or delivery

Speak very clearly – and speak to not at your audience.

Speak slowly, but not so slowly as to bore your audience.

Present a single idea or fact in a variety of ways by varying your construction and voice modulation. Remember to present only one new idea every 3 minutes and repeat it in order to allow your audience to pick up the idea.

Adopt a simple, conversational style – do not shout at your audience.

Be relaxed and confident. Look at the audience, not at the floor or out of the window, no matter how shy you may be.

Allocate your presentation time in the following suggested pattern:

– Introduction 35%
– Methods 40%
– Results and discussion 25%.

Pause after each new slide 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 cable, or fiddling continuously with the microphone, and 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 tell them the implications of what you have said (Conclusion).

If possible, complete your presentation 2 minutes before your allocated time is up. Do not get into a running battle with the Chairperson, who will be struggling to stop you talking. Give other speakers a chance to present their work as scheduled in the conference programme.

At the end of your presentation, thank the chairperson and the audience for their attention.

Anthony Youdeowei

Preparing
scientific posters

12

12.1
Introduction

Agricultural research results are sometimes presented as posters, which are usually mounted on the walls of rooms or along the corridors of research institutions. During scientific conferences, it is common to find many scientific posters on display in specially assigned poster display rooms.

At some scientific meetings, special poster sessions are organised during which scientists stand by their posters to answer questions and provide explanations.

12.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– understand the basic principles in the use of posters for communicating agricultural research results;
– plan and design poster presentations of research results for conferences.

12.3
What is a scientific poster?

A scientific poster is a single large page containing all the information to be communicated. In effect, a poster is an abridged form of a journal article, and therefore follows the IMRAD (Introduction, Materials, Results and Discussion) format (see Chapter 3).

Posters are a highly effective scientific communication medium generally used at technical workshops, conferences and other scientific meetings.

A poster can also be used effectively to present pictures that tell a full story or a research activity, as well as the results. Information in a poster is provided mainly through the use of visuals, so an effective poster must be visually appealing.

The main aim of a scientific poster is for the information to be presented through the use of visuals in a well coordinated and organised combination of text and illustrative matter.

A good scientific poster should:

– be simple and highly informative;
– tell the story fully and completely;
– 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 combined harmoniously to produce an effective presentation;
– contain minimal colour clashes, which can confuse readers.

12.4
Major elements in a scientific poster

The examples in Box 12.1 illustrate how the subject matter of a scientific poster determines its elements.

Box 12.1 The subject of a poster dictates its elements

A poster reporting the results of research

Title of the poster – text.

Introduction – text.

Materials and methods – text and illustrations.

Results – text and illustrations (graphs, histograms, photographs, line drawings or even actual specimens).

Conclusions – text and illustrations.

A poster describing the life cycle of the rice stem borer and its damage to the rice plant

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.

Photographs or drawings with short descriptive legends.

Distribution of the rice stem borer within the geographical region of concern (e.g. a well labelled map of West Africa to indicate its occurrence in different countries).

A poster on WARDA's West African Rice Information Services (WARIS) project in Bouaké, Côte d'Ivoire

Colour photographs of the WARDA library and documentation centre, showing shelves with books and journals.

Photographs of WARDA library staff involved with in-house document production and distribution of documents to rice scientists.

Text that explains briefly the range of information services on rice science provided by the WARIS project.

Photographs of the range of CD-ROM agricultural databases available at WARDA.

12.5 Preparing a poster

The following steps are suggested for preparing a scientific poster.

– Before you start preparing a poster, decide on the precise topic and subject matter you wish to communicate; ensure that the story is interesting and possibly new.

– Then proceed to plan the poster in the same way as you plan a research article for a journal (see Chapters 3 and 4).

– Write the complete text of the story. Revise it thoroughly until you are satisfied that all the information you wish to communicate has been included.

– Edit the text conscientiously to make it brief, without compromising on technical quality or details.

– Identify the parts of the text 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 the design carefully. When you are satisfied with it, give approval for the artist to proceed with finalising and producing the poster.

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

– Plan, write and edit the text of your poster.

– Decide on what you wish to illustrate.

– Arrange to make large prints of the pictures you need for the poster.

– Make a large sketch of the graphs and diagrams you plan to include. The relative importance of the material being illustrated will determine the relative sizes of your illustrations.

– Set the text in large font sizes, about 20–36 point. Make the text concise, brief and clear.

– Print out the text groups onto separate sheets of paper, the sizes will vary according to the amount of text.

– Check on the overall size of the poster. If you are preparing for a conference, the organisers will usually provide information on the maximum poster size.

– Prepare a rough layout plan to scale (Figure 12.1), indicating where each element will fit in the final poster.

– Using this layout as a guide, measure the actual sizes of the text and illustrative matter and fit them on a full-size dummy of the poster sheet.

– Paste the various sections onto your poster sheet – ensure they are in straight lines, both vertically and horizontally.

– To enhance the appearance of your poster, you could print the text on coloured paper, or print it on white and paste the text blocks onto contrasting coloured paper. Photographs, drawings and graphs could also be pasted onto contrasting colour backgrounds.

Figure 12.1
One example of a rough poster layout plan.

Review your poster critically with a colleague, specifically noting the following:

– clarity of the message;
– visual appeal and colour scheme;
– readability;
– balance of text and illustrations.

If you are sufficiently computer literate, or have access to desk-top publishing (DTP) facilities and expertise, you can prepare your poster electronically using standard DTP software such as *PageMaker*, *PowerPoint*, *CorelDraw*, *Adobe Illustrator* or *InDesign*. Once the poster has been designed using the computer, it can be printed to any size you desire. To do this, copy the file to a pen drive and take it to a reliable printer with appropriate facilities to print out your poster to the desired size.

Finally – never leave home to go to a scientific conference without the poster you have prepared to communicate your research work – save yourself the embarrassment!

12.6 Displaying your poster

Here are some important points to remember when you display a poster at a conference poster session:

– display your poster at the point allocated to you;
– remember to stand by your poster at the appointed time/s to interact with people viewing it;
– anticipate questions and prepare answers;
– remember to include your contact information in the poster.

"Posters are a highly effective scientific communication medium generally used at technical workshops, conferences and other scientific meetings"

Anthony Youdeowei

Writing research proposals and reports

13

13.1
Introduction

Writing research proposals is a major and essential activity of practising research scientists. Without research proposals, funding for research will become highly elusive or even non-existent. Scientists must therefore develop a reasonable level of skill in writing grant-winning research proposals; these skills are developed and fine-tuned through regular practice over many years.

Research project proposals are, in essence, mini-research papers that have not reached the stage of actual implementation. Research proposals have a number of well defined elements that, if carefully put together, should result in successful funding for the project.

This chapter provides general guidelines on the elements of writing grant-winning research proposals.

13.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– analyse the elements of a winning agricultural research proposal;
– develop the skills to write winning agricultural research proposals that meet the needs of potential in-country and external donor agencies.

13.3
Writing a research proposal

Just as when writing a research paper, you should carefully determine the target of your research proposal before you start writing. Different donors have well defined priorities and specific requirements for their project funding applications. These priorities are not constant, and are modified periodically according to the changing focus of development assistance policies and strategies. Fortunately, most donors publish comprehensive handbooks and guidelines that detail how proposals should be constructed. The guidelines for construction of project documents are also posted on the websites of the donor organisations.

The basic elements that usually form a research project proposal include:

– Title;
– Project leader;
– Executive summary;
– Abbreviations and acronyms;
– Definition of the problem and justification;
– Objectives;
– Expected outputs;
– Methodology;
– Collaborators;
– Time frame for project implementation;
– Project work plan;
– Logical framework;
– Project budget.

These elements are arranged in different ways by different donor agencies. Before embarking on writing any project proposal, you should obtain the specific guidelines for preparing and submitting project documents to the particular donor agency of your choice.

For example, the approved structure, from year 2010, for the Technical Cooperation Project document of the Food and Agriculture Organization of the United Nations (FAO) is shown in Box 13.1.

Box 13.1 FAO Technical Cooperation Programme
Index of the Project Document Format

Cover Page
Executive Summary
Table of Contents (optional)
Acronyms (optional)

1 BACKGROUND
– 1.1 General Context
– 1.2 Sectoral Context
  – 1.2.1 Development priorities and MDGs
  – 1.2.2 Relations with NMTPF and UNDAF
– 1.3 Sectoral Policy and Legislation

2 RATIONALE
– 2.1 Problems/Issues to be Addressed
– 2.2 Stakeholders and Target Beneficiaries
– 2.3 Project Justification
– 2.4 Past and Related Work
– 2.5 FAO's Comparative Advantage (optional)

3 PROJECT FRAMEWORK
– 3.1 Impact
– 3.2 Outcome, Outputs and Activities
– 3.3 Sustainability
– 3.4 Risks and Assumptions

4 IMPLEMENTATION AND MANAGEMENT ARRANGEMENTS
– 4.1 Institutional Framework and Coordination
– 4.2 Strategy/Methodology
– 4.3 Government Inputs
– 4.4 FAO Contribution

5 OVERSIGHT, MONITORING, MANAGEMENT INFORMATION, AND REPORTING
– 5.2 Monitoring and Knowledge Sharing
– 5.3 Communication and Visibility (optional)
– 5.4 Reporting Schedule

ANNEXES
– Annex 1 Budget
– Annex 2 Logical Framework (optional)
– Annex 3 Work Plan
– Annex 4 Terms of Reference for International and National Personnel

"

Research project proposals are, in essence, mini-research papers that have not reached the stage of actual implementation

"

A few comments on some of the basic elements now follow.

13.3.1 Title

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

13.3.2 Project leader

With most research project proposals, you will need to designate a project leader and include an abridged curriculum vitae. Donors wish to know who will be responsible for leading the project. Most donors specify requirements that are detailed in the project fund application forms. If there is no requirement to designate a project leader, give at least the name, institutional and correspondence address, details of qualifications, experience and a list of similar project leader assignments undertaken, and a list of selected publications.

13.3.3 Executive summary

The project document should have an executive summary which is comprehensive, detailed, not too long, and written in a logical sequence.

Assessors will often base their preliminary judgement of your project's merit and immediate suitability to the needs of the potential donor on the executive summary. In just a few sentences you should justify the project, outline the work plan, and describe the expected outputs and their significance.

13.3.4 Abbreviations and acronyms

This list contains the meanings of all the abbreviations and acronyms used in the project document.

13.3.5 Definition of the problem and justification

Examine the background of what the project is aiming to do; say briefly why you think the work should be done; and relate it to what is already known, or to similar work that has been done by other researchers on this problem.

13.3.6 Objective

State what you want to achieve through conducting the research. Your statement might have two levels, for example, an immediate objective that the project activities will achieve, plus a long-term development objective to which the project will contribute.

13.3.7 Expected outputs

The expected outputs indicated must be significant, but also finite and measurable. For example, do not say that you intend to increase productivity in the Sahelian sub-region; rather say that you 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 main faults of many project proposals – the outputs are not clearly defined, and therefore it is impossible to determine when the project has achieved its objectives.

13.3.8 Collaborators and partners

List the names of any national or international scientists or organisations that will collaborate as partners in executing the project activities. The role of each of these partners or collaborators should be clearly stated. The consent of collaborators and partners should be sought before they are included in the project proposal.

13.3.9 Time frame for project implementation

Early in the proposal, you should indicate the duration of the project (e.g. 18, 24 or 36 months). This time frame is different from the work plan or timetable of research project activities.

13.3.10 Project work plan

Describe the timetable of activities that you intend to follow for project implementation. Specify the time, during the project cycle, when each of the project activities will be scheduled. Note that specific project outputs lead to other outputs, and this pattern should be reflected in the project work plan.

13.3.11 Logical framework

Some donors specify that all project proposals submitted for funding should include a logical framework (log frame); they also provide a format for preparing the log frame.

The log frame is a project planning and management tool which is commonly used for guiding implementation, and subsequently provides an evaluation instrument for project evaluation. The log frame is presented as a simple table or matrix that clearly summarises the project elements, with associated indicators, means of verification, impact, outcomes, outputs, project activities, and important assumptions that are likely to influence the successful implementation of the activities. These elements of the log frame are presented in a matrix like the simple version in Table 13.1.

**Table 13.1
Example log frame**

Project objectives:			
Design summary	Indicators/targets	Data/sources of verification	Assumptions
Impact			
Outcome			
Outputs			
Activities			

– The **impact** is the goal of the project – what influence the project's implementation will have on the intended project beneficiaries.

– The **outcome** is the expected result of the project, which is a consequence of the impact.

– The **outputs** are the achievements realised through implementing the project activities.

– The **activities** are the specific actions taken during project implementation (e.g. training of women cowpea farmers in the adoption of integrated pest management practices for cowpea production).

Thus the activities involve the actual actions taken; the outputs are what those actions accomplish.

13.4
Project budget

The budget is the most important part of the project document. Donors always provide guidelines and formats for constructing budgets for the projects they fund. The budget must be prepared to comply strictly with the format specified by the potential donor. The budget must be realistic, detailed and accurate, listing personnel costs, equipment, materials and supplies, travel, and any other significant expenses. Personnel costs may include support staff to be recruited specifically for the project, part-time or full-time administrative and technical staff involved in the project, and consultants. Cost each budget item carefully and make provision for inflation, as there is usually a long time lag between applying for project funds, getting approval and release of funds. Do not include large amounts for contingencies or other vague purposes. Include a spending plan of when funds will be required throughout the life of the project. You may have to justify travel to meetings separately, apart from travel for conducting project activities.

Finally, remember to include reporting costs – the costs of preparing research reports and publishing articles that will emerge from the research activities.

13.5
Writing project reports

If your proposal is well written and successful, you will receive a grant from the donor to execute the research project. As you execute the 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 progress and final reports, and financial reports.

The scientist usually prepares the research report; the financial report is prepared by the financial officer of the institution in consultation with the scientist. In addition to preparing research reports for donors, scientists in research institutes are usually 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 report of research execution;
– end-of-project report;
– annual report of research.

13.5.1 Preparing project reports

Before writing a project report, you should make decisions about:

– the kind of report needed – a progress report, an annual report or a final report;
– particular aspects of the research work that are mature enough to be reported;
– the pattern of the report;
– the required schedule for submitting the report.

Some donors provide guidelines for preparing research and financial reports. In such a case, you should follow the format provided strictly. It is in your own interest to do so in order to satisfy the donor and remain in their good books, to receive favourable consideration of future project proposals.

When no special format is provided, research reports are usually prepared according to the Introduction, Materials, Results and Discussion (IMRAD) formula (Chapter 3).

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

– Title;
– Name of author/authors;
– Addresses of author/authors;
– Executive summary;
– Introduction;
– Materials and methods;
– Results;
– Discussion and conclusion/recommendations;
– Acknowledgements;
– References;
– Annexes.

Note that the structure of a research report is similar to that of a research paper, except that a research paper may contain an annex, which could be a summary of data from which the text tables were prepared, or some other materials to which reference is made in the body of the report. The research report should be organised to conform to 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 in Chapter 3 for writing a research paper.

One final tip – within every research report, remember to acknowledge the financial support received from the donor for conducting the research project.

Rodger Obubo

Communicating science to non-scientific audiences —

the popular media, governments, policy- and decision-makers

14

14.1
Introduction

"If the reader is to grasp what the writer means, the writer must understand what the reader needs."

(Gopen and Swan 1990)

As well as communicating their research to their peers in the scientific community, agricultural researchers also need to reach various stakeholders with their findings, in the language and format best suited to these target audiences. This chapter addresses this need, and guides researchers to appreciate the need for this type of communication, identify and choose the channels, and develop the appropriate messages.

14.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– discuss the need for communicating with a wider audience than the scientific community;
– identify the different non-scientific audiences and types of media appropriate to each audience;
– describe the special requirements when writing for a broad audience;
– adapt the content of a scientific paper to a news story for the general public.

14.3
The importance of communicating science

Communication can be defined (using the *Macquarie Little Dictionary*) as "to give to another, impart, transmit; to make known; to have an interchange of thoughts". This definition summarises three concepts:

– awareness-raising – to make known;
– information exchange – to give to another, impart; transmit;
– dialogue – to have an interchange of thoughts.

Agricultural researchers may think that they and their research are somehow removed from the mainstream – from the general public and the media. However, they have to realise that for their work to be meaningful to the stakeholders they serve, there must be effective communication.

It would be impossible to keep up to date on all the latest scientific findings, in all disciplines, without the various channels of communication that make it possible for research results to be transmitted in formats that are more easily comprehensible by a broad audience of non-specialists.

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

Writing up research results in a popular and human way for non-scientific audiences does not trivialise or demean the work; it simply makes the role of researchers in society more relevant.

14.4
Target audiences and their characteristics

Thinking about your audience is essential to developing and conveying your message effectively. Within the general public are audiences that are crucial to researchers:

– donors (both national and overseas), who decide what research (and which researchers) receive funding;
– taxpayers, who foot the bills and elect the people who become policy-makers;
– policy-makers, whose decisions may be influenced by research findings, and whose biased preconceptions could block your funding;
– educators, trainers and extension officers, who transmit research findings, and whose understanding and acceptance of your findings will facilitate their adoption and use;
– user groups, who benefit from research findings, and whose questions and comments will improve your research direction;
– potential collaborators, who may want to work jointly with you on future projects.

14.5
Choice of communication channels

There are many ways of communicating to the general public the value of agricultural science and the potential benefits of the research undertaken.

14.5.1 Which channel, 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. Scientists will need to tailor their messages to suit the target audience, without compromising the quality of the message and the validity of the science.

The most common communication channels are listed below.

Press conferences
Consider inviting the press to a scientific conference that your institution or network is organising. Identify presentations that may be of interest to the media, and structure your invitation around these.

Press releases
Issue a press release on the day of the conference, highlighting presentations and items of general interest.

Feature articles
Write feature articles on your area of research for newspapers and magazines, in collaboration with the media.

Field days and workshops
These could offer a guided tour of research facilities and outputs, and conversations about the kinds of work researchers are doing. They can be a very good platform for invited key stakeholders – donors, policy-makers and farmers' associations – to obtain a first-hand view of the research being done. They also offers opportunities for explanation at face-to-face level.

Interviews and documentaries

Programmes on radio and television are also very effective for the communication of your scientific findings. Television can have a very vivid effect when a production is supported by multimedia – using sound, images, script and interviewees to tell a story. In this regard, a camera with still and movie functions is an indispensable tool of the researcher.

Online

Recent developments have made it possible for researchers to publish their stories on the internet via web logs (commonly called blogs) and other web-based platforms. A scientist can dedicate a blog to a given area of research interest. One interesting advantage of blogs is that readers have the opportunity to provide direct feedback by making comments directly to a blog post. Readers can reach your blog by searching on the web for the specific area or interest or topic.

14.5.2 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 in-depth news items and analysis, and more features. It is in the latter that serious articles on science are most likely to appear.

14.6
Key considerations in writing for non-scientific audiences

14.6.1 Writing popular articles for publication

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

Just as you choose a scientific publication for your research paper, so you should consider what kinds of media, publications and audiences 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 publishing 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 the type of publication, which may be general circulation, or more specialised according to subject, age, profession, nationality, region, gender, level of expertise, or specific language specialisation, for example.

Writing popular articles is not very different from writing scientific articles. 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 generally. Most of what is covered in Chapter 3 is applicable in popular writing as well.

There are, however, some basic differences.

14.6.2 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.

14.6.3 Headlines

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. It pays to use a catchy or "sexy" title (Box 14.1).

Box 14.1 Finding the right title

Rhizobial inoculation of mature *Acacia senegal* (L.) Willd. trees increases gum-arabic production and affects the soil microbial functioning

try instead

Increasing gum-arabic production: a fungus to the rescue

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

14.7
Writing news stories

News stories are ultimately human interest stories. Their general acceptance as news depends on the ability of the researcher and reporter to find and convey the human interest angle within the research story.

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 IMRAD format summarises the logical sequence of presenting scientific research to other scientists. 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 will "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 of 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 organisations);

– 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.

14.8
Features, opinion pieces and magazine articles

Features and articles (which are longer and more literary than news stories) are the most common format for science in popular publications. Most often, such articles are between 1000 and 3000 words long – and the editor will 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 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. Here, as well, 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 the story together, 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 both researcher and the reader, why the research is important. This is always useful, particularly when you are writing research proposals to solicit funding.

14.9
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 – and who really cares?
– policy – how does a publication, radio or TV station view different events?

14.10
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. These may include:

– 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 by 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.

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" Agricultural researchers have to realise that for their work to be meaningful to the stakeholders they serve, there must be effective communication "

Pippa Smart

Publishing an article in an online journal

15

15.1
Introduction

This chapter provides information about the different types of online journals that scientists may encounter. It also explains some of the different expectations that authors and journals may have in regard to online publication.

15.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– understand, and make informed decisions about, online publishing;
– explain what open access is, and what benefits and disadvantages it can
  bring to journals and authors;
– identify what online benefits are important to authors and readers;
– feel confident to submit your articles to an online journal.

15.3
Research communication

Research communication has been greatly affected by the growth of the internet, and has made substantial use of this medium to improve the speed and efficiency of disseminating research results. The speed of communication and the potential of speaking to researchers throughout the world have led to rapid adoption of the web throughout all sectors of practitioners, researchers and academia. It has also affected how researchers work, encouraging greater inter-country collaboration and discussion.

The internet has also changed expectations – for example, authors are no longer willing to wait months (or even years) to have their work published, and there may be reduced credibility for articles that are not available online. It has also affected readers' expectations, and it is now required that articles make reference to current thinking and discoveries.

15.4
Different flavours of online journals

When journals started to publish online they were usually facsimiles of the print version, but this has changed, and you need to be aware of the different types of online journal now available.

15.4.1 Online-only

In the past few years, an increasing number of journals have been launched as online-only titles (e.g. The *African Journal of Traditional, Complementary and Alternative Medicines*, 2010, www.africanethnomedicines.net/journal.php). At first these journals were considered inferior to journals that retained a print format, and some indexes would not include them. The concern was that they were ephemeral compared with print titles, and that the quality of their content was suspect.

Time has shown that online titles are not as ephemeral as originally thought, and there is now increasing acceptance of them as valid publications. Major indexes include them on an equal footing with print journals, and academia is accepting them as valid publications for their staff to publish in and use.

With regard to quality, it is accepted that the quality of a journal is not determined by its format – print or online. A quality journal is one that has a respected editorial board, and that publishes articles that are quality assured (usually through peer review). There are many print journals that do not conform to this test of quality, and many online-only journals that enforce a high level of quality control. There is a

misconception in some areas that online journals do not review their content, but this is an unfair simplification: some journals do not control the quality of what they publish – but being online or in print has no direct correlation with this.

15.4.2 Online extras

Almost as soon as journals started to publish online, they introduced some differences between the online and the print versions. The most common online extra is the use of colour. Many journals cannot afford to print colour images (unless authors subsidise this), but they can use colour online. Therefore it is relatively common for a print journal to contain a black-and-white image that is available in full colour online. Some journals allow authors to supply additional content that will appear only in the online version of the journal. A good example of this is the addition of appendices or data sets, or sometimes additional images. The reasoning behind this is the cost of printing – if the author wants to include a long descriptive appendix (perhaps 20 pages), this may be too expensive to print, but there is little cost in placing it online.

15.4.3 Different online and print versions

When journals started to publish online as well as in print, the online version was a facsimile of the print edition; however, there are now increasing examples of journals that publish a different selection of content in print and online.

A good example of this is *South African Family Practice* (www.safpj.co.za), the bi-monthly journal of the South African Academy of Family Practice. The online journal publishes original research articles. The print version includes only abstracts of these articles, plus other content including news, views, meeting dates, profiles, and other more general content. Another high-profile example is the *British Medical Journal* (BMJ). The full text of all accepted research articles is published online (bmj. com) in full, with open access and no word limit, as soon as it is ready. BMJ pico is a one-page abridged format of these articles that appears in the print journal. The reason for this split of content is to save pages in the print journal and allow the journal to carry more content.

15.4.4 Online early

One problem with journals is the delay between submission, acceptance and final publication – with some journals performing better than others. This is a particular problem in fast-moving areas of science, such as physics and molecular biology – but no less frustrating for authors of social science and humanities papers. In the paper environment, authors are forced to wait for the issue collation and printing, but many online journals have adopted policies for pre-publishing articles to ensure the content is available as soon as possible.

An example of one model is the journal *Atmospheric Chemistry and Physics* (www. atmospheric-chemistry-and-physics.net). This journal makes an initial evaluation of papers submitted to it, and if they pass this they are posted on the site for further comment by readers (an open peer-review system). After a period of time, the article is taken down and the author is asked to revise and re-submit it. It then goes through a traditional peer-review process, and on acceptance it is formally published. This approach provides an early "publication" of the author's work.

More commonly, many journals from large publishers put the accepted papers (those that have been reviewed and are scheduled for publication) on their website in advance of the issue publication. At this point the articles can be cited by users as "in press". An example of this is the "early view" service provided by Wiley-Blackwell. In this system, articles scheduled for publication are made available (to subscribers) on a separate part of the journal's website. Once they have been selected for an issue, and that issue is published, the "early view" article is taken off the site (www3.interscience.wiley.com/aboutus/journals.html).

In all cases, authors can request that their papers are not pre-published if they have a reason to do so (perhaps they have a patent pending). However, pre-publication means the article can be read and cited sooner than awaiting final publication – and this can be a benefit to the author (as well as the research community).

Note that once an article is made available, it is associated with the author and the research contained within the article is attributed to the author. Therefore pre-publication can help to protect authors against their work being "stolen".

A few journals publish each article as it is ready for publication – not pre-publication, but incremental publication as a replacement for waiting for issue collation. An example of this is the *South African Journal of Chemistry* (http://journals.sabinet. co.za/sajchem). This journal opens the volume each year on 1 January and adds papers as they are ready. At the end of the year, the volume is closed.

The largest journal in the world operates in this manner. *PLoS One* is a journal launched in 2007 that publishes medical articles as soon as they have been accepted and formatted, grouped into annual volumes (www.plosone.org).

15.5 Online publishing formats

Most journals publish articles in PDF format. This mimics the look of a printed article, and is nice to print out – but it is not easy to read online. Ideally, online journals should publish articles in HTML format (as a web page), plus PDF.

Publishing in HTML has several advantages: any hypertext links are quick to work and provide a seamless way for users to navigate the content; also HTML pages are often a smaller file size than the equivalent PDF, and so open more quickly where online access is slow.

PDF is an ideal format for printing out, as it provides a neat and tidy series of pages which are easy to read. However, file sizes can be large, so opening a PDF article can be slow when internet access is not ideal.

Usually the article title and abstract are made available in HTML, free for anyone to look at. This is very important as the abstract is frequently read to determine whether the entire article is of interest to the user. It is important, therefore, that the online journal provides easy access to the abstract.

Some journals allow the author to publish content in other media – audio files, video clips and animated illustrations. In some instances these can greatly add to the readers' understanding, so if the author feels they are required, it is important to choose a journal that allows them.

15.6
Online benefits

The online environment provides a great opportunity to make journal content interactive. Some journals have added a discussion forum, encouraging readers to comment on the articles and to engage in debate. The online environment also provides a more efficient way to update content and correct errors than the traditional errata published in print journals.

However, the most important benefits that online journals bring are searching, hypertext links, alerting, wide dissemination and usage statistics.

15.7
Searching

Online search facilities are used extensively by researchers. There is evidence that more researchers rely on search tools (e.g. *Google* and *Google Scholar*) than they do on browsing issues of journals. Therefore it is important to ensure your article has a clear title, and to use suitable key words within the title and the abstract, as these will help to make sure your articles are discovered when users search for their area of interest.

Due to the website design, some journals cannot easily be searched by the online search engines (*Yahoo*, *Google*, etc.), so it is important to select a journal that has high online visibility. You can check this by searching for the journal online and seeing if the search engines find it quickly.

15.8
Hypertext linking

One of the most important developments in online publishing has been the introduction of linkage. The most common (and arguably most useful) type of linkage allows readers to navigate from a text citation to the full reference at the end of the article, and from there directly to the article cited.

In a survey of authors undertaken by Association of Learned, Professional and Society Publishers in 1999, Swan and Brown (2003) found that reference linkage was one of the most valued additions to online journals – since it allowed readers to undertake their information research easily, moving from article to article. There is also more recent evidence which shows that authors more frequently follow (and repeat) citations that are linked – so if a reference within the article list does not have a link to the article on the web, it is less likely to be used and cited by the reader (Evans 2008).

When writing an article (regardless of whether it is for a print or online journal), it is now increasingly important to give a web address for the references (where available) so that the reader can look them up online. Where a submitted article includes a web address within its references, this can be used by journal publishers to add a hypertext link within the online article.

The most common web address to include is the URL (e.g. www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0001470). However, these are clumsy, and are also vulnerable to changes in the online location and can lead to dead ends. Where it is available, the article DOI should be used (e.g. DOI: http://dx.doi.org/10.1371/journal.pone.0001470). The digital object identifier (DOI) is a unique number that identifies an article and is used by the journal publisher to provide a permanent hypertext link to the article (very useful when the URL of the article changes). These are usually displayed at the head of the article with the citation

information. They can also be found using the CrossRef website guest query form: www.crossref.org/guestquery. By entering the publication details into this form, you can look up the DOI, which can then be cut-and-pasted into the reference.

15.9
Alerting

It can be extremely important for journals to set up alerting systems to tell users when a new issue (or a new article) has been published. This brings readers back to the journal, instead of relying on them to go to the website in the hope that a new issue has been published.

There are three systems for alerting – table-of-contents alerts, search alerts and RSS feeds – depending on the sophistication of the publisher, only some of these may be available.

The most common is a table-of-contents alert, where a user signs up to receive an email every time a new issue is published. An RSS feed is similar, but instead of sending an email, it adds the alert to the user's RSS reader, which may be online, on their desktop, or on a mobile device. A search alert allows the user to undertake a search for preferred terms, and then to be alerted whenever articles matching these terms are published.

These types of alert are very important to promote the journal – and ensure that potential readers are alerted to the articles that have been published.

15.10
Usage statistics

All online journals should provide authors with usage statistics – how many times has their article been downloaded, and (if possible) from where (which countries have accessed the article and downloaded it). This is an important metric for authors to use to determine the importance of their article. To avoid inflated ideas of how many downloads to expect, the journal should also provide an average download figure so authors can compare their article against others published in the same journal.

The journal *PLoS One* provides a variety of metrics on its site, which are made available to all users as well as authors. See www.plosone.org/static/almInfo.action and consider what benefits this type of information would bring to users as well as authors.

15.11
Dissemination
– open or
closed access

You should be aware of how accessible your article will be when published, as this will affect how many people read and subsequently cite your work. In the print environment, this is restricted to the number of subscribers and other people who receive the journal. In the online environment, access to the full text may be similarly restricted, but non-subscribers will also be made aware of articles when they appear within a search result.

One additional factor that can greatly improve dissemination of a research article is whether or not it is open access.

Since the advent of on online publication, there has been a growing movement arguing that research information should be made available to all who need it – and especially to those who funded the original research (the authors' parent institutions, the funding bodies, and the taxpayer).

These concerns have led to two parallel developments: article repositories and open access online journals.

15.11.1 Article repositories

Technology has been developed to allow institutions to place their research content (theses, articles, working papers, conference proceedings, etc.) within a database that is then made available within the university's intranet, or to the world on the internet (Lynch 2003). These developments are called institutional repositories (IRs), and there has been a tremendous growth in their number, particularly within European and American Universities, plus recent developments within Africa (there are more than 2700 registered IRs around the world – see http://roar.eprints.org/view/geoname).

There are also some subject-specific repositories to capture any article/paper within a particular discipline. One of the best established is www.arxiv.org (for physics papers) and another is www.ncbi.nlm.nih.gov/pubmed (for biomedical and health papers). These are not tied to a particular institution, and operate as community sites, frequently allowing commentary on the articles that authors place within them.

The relationship between these repositories and journals has developed from one of suspicion (with journals unwilling to accept articles that have been already "published" in a repository) to a situation where the majority of journals accept that funding and institutional rules require authors to place their article in these systems, and that it does not undermine journal publication.

When submitting to a journal, you should consider if there is a repository that you should also be placing your article into – for example, within your own institution. You should check (1) that the journal to which you are submitting allows this; (2) what article version the journal allows you to submit – the submitted manuscript, the accepted version (after peer review) or a PDF of the final article; and (3) if there is an embargo period – for example, not allowing you to post your article onto the repository for 6 months after publication. Also, it is important to remember to provide the published citation information on the article in the repository, so that readers can find the "final" published version – and cite this.

15.11.2 Open-access journals

Open-access journals allow any users, anywhere in the world, to access and read the full journal article (on the journal website) without a subscription. The articles should also be free for anyone to re-use (with full citation) in course packs or in other publications.

There is some evidence that making articles available free online increases the use of the article, and therefore enhances the impact of the research behind it. However, there is also other research that disproves this. The general rule is that, although publishing open access should increase the number of readers, it is still the quality and relevance of the article to users that will determine whether or not they cite it (OpCit Project 2009).

There are different financial models for open-access publishing, and many journals require authors to pay publication charges. Some ask for a small submission fee to

cover the peer-review process, and then a second payment if the article is accepted. Some journals offer authors the option to purchase open access for their article (if they do not pay, the article remains subscriber-only access) – this is often called a hybrid model. Most journals are willing to waive payment charges if the authors are unable to pay, although they may not publicly state this. The amounts required by the journals vary considerably.

15.12 Writing an article for an online journal

Writing an article for print-only or for electronic-only journals requires the same skills and quality of presentation. The only difference is that an online journal may allow different types of materials to be submitted – for example, colour images, audio recordings, perhaps videos.

For basic instructions on how to write and publish a scientific article, see Falaiye and Smart (2004) and Mainali (2005).

One word of warning about writing for online-only publication. It is tempting to make online-only articles very long, as there is often no fixed word count (as there usually is in the print environment, where every page costs money to print). However, readers have only a short attention span – and this is often shorter online. A good article is precise and concise, and no longer than required.

15.13 Submitting an article for online publication

Many journals now require online submission of articles – even if the journal does not publish online. Submitting online makes the process of peer review and final decision faster, as there is no reliance on slow postal systems. However, it does require you to be able to digitise everything in your submission – the text, as well as any illustrations and other content.

Most journals provide detailed author instructions for submission – and if they do not, then they should! In general, text should be submitted in a word-processing file, and all illustrations should be submitted in a generic file format – tiff, jpg or eps.

If the journal includes different content for the online and print formats, this should be clearly indicated when submitted – for example, if you want a figure to be in colour online, but black-and-white in print, you need to ask if two versions need to be submitted, or if the journal will take responsibility for changing the colour figure into black-and-white.

15.14 Copyright in online journals

Copyright and the rules surrounding fair (reasonable) use of content are exactly the same in the print and the online environment. There is some fear that, because it is so easy to cut-and-paste from an online article, this will lead to greater piracy and theft of content; conversely, it is also easier to detect plagiarism in the online environment.

Whether publishing in a print or online journal, you should:

– make sure you have permission to reproduce any previously-published content;
– ascertain what rights you have to re-use your own content after publication.

If you reproduce any previously published content (e.g. an illustration from a book), then you must obtain permission from whoever owns copyright in that content. This

permission must be given in writing (an email may be sufficient). Sometimes a standard permission form will include only permission to reproduce the content in print, so if you are publishing in an online journal you must make sure that online permission is granted.

When you submit your article to a journal (whether in print or online), you must explicitly grant the journal permission to publish your work. Commonly, journals require you to assign copyright to the journal – this means that the journal "owns" the content and you may not do anything with it (e.g. use it in teaching literature, republish it, etc.) without permission from the journal. Most copyright assignment forms clearly state what rights the author retains, and good journals will allow you to use your own article for non-commercial purposes, such as teaching, without seeking permission from the journal.

More enlightened journals now use a "licence to publish" form, in which you as author retain copyright in the article, but grant the journal the right to publish your work. This means that you can re-use your work where you wish without permission, and that the journal needs to obtain permission from you if it wants to re-use your work in any way. You should note that many such licence forms grant the journal "exclusive" rights to publish your work, so you may still not be able to republish your work elsewhere.

When submitting online, many journals simply ask you to tick a box that confirms your acceptance of the copyright agreement with the journal. Other systems require you to sign and return a printed form. Before signing any form (or ticking an online box), you should ensure that you have the authority to do this – that you own copyright in what you are submitting. If the article was written as part of your employment, you may not be able to assign it without authorisation from your institution.

15.15 Summary

Publishers and journals are experimenting with online publication, and there are some very interesting developments which you should be aware of. It is recommended that you look at *PloS One*, and also at the journal *Cell* (www.cell.com), which is using a new presentation for online articles (articles published in the first four issues of 2010 are freely available).

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15.17 Exercise – Online journals

What benefits does publishing in an online journal bring to authors?

What benefits does publishing in an online journal bring to readers?

Is there any reason why you should not submit your article to an online-only journal?

Would it be better to publish in an open-access journal than a closed-access (subscription only) one?

Does publishing online make any difference to copyright and copying of articles?

Are there any differences between writing for an online-only or a print-only publication?

What information should you require online journals to provide?

What good online journals are you aware of? What do you like and dislike about online journals that you have used (as author or reader)?

Paul Neate

Publishing ethics and intellectual property rights

16

16.1
Introduction

There is a strict code of ethics in the field of scientific publishing, which is aimed at ensuring the quality and integrity of information that is published. Ignoring this code can have dire consequences, ranging from your being blacklisted by key journals to jeopardising your scientific career.

16.2
Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– understand the ethics of scientific publishing;
– conform to the international recognised conventions surrounding copyright and intellectual property.

16.3
Principles of publishing ethics

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 any of these statements is not true, you should not submit your material for publication.

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

16.4
Double publishing and multiple submission

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

Another practice that is frowned upon by many journal editors is "salami publishing". This is where authors break their work down into "minimum publishable units" (O'Connor 1991) to try to get as many publications as possible out of a piece of research. If a journal editor believes you are practising salami science, he or she may reject later "slices" on principle. Author beware.

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 of considering a paper 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 write-ups of research.

If you have already published an article 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. 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. Prior publication may not mean that your paper is automatically rejected, but telling the editor is common courtesy and will protect you from later misunderstanding.

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 to a journal later, 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.

16.5
Plagiarism

"If you steal from one author, it's plagiarism;
if you steal from many, it's research."

Wilson Mizner, American screenwriter

Plagiarism – passing off others' words or ideas as one's own – is considered scientific misconduct and is taken very seriously.

With the advent of the internet, it is easy to access vast amounts of information, and it is so easy to cut-and-paste blocks of text to help your writing along. But if you do this and do not acknowledge the source, and that the material is a direct quotation, this is plagiarism and tantamount to theft. Don't do it. Because you will get caught – the internet also makes it easier to identify copied text and where it came from. At best it will be embarrassing; at worst it will be a serious black mark against your name. You should also note that extensive paraphrasing of others' work without acknowledging the source of the original material is also considered plagiarism – simply rewriting the material in your own words does not make it original.

Another practice that is becoming recognised is "self-plagiarism" (Green 2005).

"Self-plagiarism occurs when an author reuses portions of their previous writings in subsequent research papers. Occasionally, the derived paper is simply a re-titled and reformatted version of the original one, but more frequently it is assembled from bits and pieces of previous work."

(SplaT website, http://splat.cs.arizona.edu)

Some would argue that this has been common and accepted practice for many years. The argument that is now being made against it is that so much information is now available in various forms – journal articles, books and book chapters, web pages, secondary journals and the like – that putting out the same or closely similar information in several forms makes it more difficult to find core information on a particular topic. SPlaT also notes that "whenever a self-plagiarised paper is allowed to be published, another, more deserving paper, is not."

Some amount of self-plagiarism is almost inevitable. If you have performed a series of trials addressing essentially the same problem and using the same basic protocol but, for example, working with a different crop or in a different farming system, much of your introduction to the problem and the materials and methods will be the same or similar. It seems unreasonable to expect you to rewrite and substantially change these sections for each paper you write. Where the protocol has become a standard approach, you could consider citing the seminal paper rather than reproducing the protocol in full on each occasion, but this may not always be appropriate and does limit the free-standing nature of your papers.

You, as the author, have to make up your own mind on this issue, but it would be wise to err on the side of caution and not reuse your previous writings too liberally.

16.6
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, such as "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 in which you present it.

The following guidelines for authorship are suggested:

– the first author should be the person 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 are listed in decreasing order of contribution.

16.7
Copyright

In most countries, people who write or create anything, including graphics, photographs and designs, automatically possess certain rights over their work. This is based on the idea that if you have spent your time writing or creating something, if someone else uses it, you should expect to be rewarded for that use. You created 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. The exception to this general principle is the concept of "work for hire". Work you do as part of your normal employment, such as your research, the photographs you take to document it, and the papers you write based on your research, is automatically considered work for hire, and your employer owns the copyright. If you have been hired as a consultant, the situation is less clear-cut, but ownership of copyright should be explicitly stated in your contract to avoid any misunderstandings at a later date. For more information on work for hire, see Jassin (n.d.).

If a written work is to be published, the copyright owner (the authors or their employers) 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.

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.

16.8 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 obtain permission from the copyright holder. It is your responsibility as an author to do this. Remember, material on the internet is published and copyrighted, even if there is no copyright statement. You need to obtain permission to use material from the web, just as if it were published in a book or a journal.

Obtaining permission is not difficult. Write to the publisher giving exact details of what you want to reproduce and where you want to print it. Most publishers 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.

16.9 Open-access publishing

Open-access publishing and self-archiving are relatively new developments that you need to be aware of as a scientist. Both of these approaches are aimed at promoting free and open access to scientific literature.

Self-archiving calls for authors to deposit their articles in eprint archives at their institutions (Harnad 2001). If these archives use the Open Archives Initiative's metadata standards (see www.openarchives.org), information in these archives can be easily searched and made accessible. Free software is available to set up such archives (e.g. ePrints, www.eprints.org).

Many journal publishers now explicitly permit authors to self-archive either a pre-print (the version of their paper prior to peer review) or a post-print (the final version of the paper, following revision to address reviewers' comments) on their own or their institution's archive. A listing of publishers and their policies on self-archiving can be found on the SHERPA/RoMEO website (www.sherpa.ac.uk/romeo).

Open-access publishing is a business model that provides for:

> "free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited."
>
> (www.earlham.edu/~peters/fos/boaifaq.htm#openaccess)

Commonly, this involves the journal funding its operations through mixture of revenue-generating approaches, such as charges to authors, print sales, advertising and the like, and subsidies, for example, grants and donations. Access to the electronic version of the journal is free, but printed copies may be charged for.

A listing of open-access journals can be found at the Directory of Open Access Journals (www.doaj.org).

Many of the donor agencies supporting development-oriented agricultural research now explicitly support open-access publishing and will cover the author's costs of submitting to open-access journals. This should be built into your project plans and funding requests.

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Anthony Youdeowei
and Rodger Obubo

Conducting training courses in scientific writing

A1

This section provides a general guide for resource persons conducting training courses in scientific writing. These suggestions could be adopted as they stand, or could be adapted to suit particular circumstances to make the course relevant for a particular audience. These materials have been developed and used for several years in group training courses conducted in various countries of the ACP region.

First we present general guidelines on the process for designing and conducting training courses in scientific writing. This is followed by suggestions of a series of practical exercises that can be set up in training course situations.

Although these materials have been used successfully in several group training courses, this does not mean the ideas in them are cast in concrete. Please use them as a general framework for preparing your training materials.

A1.1 Guidelines for designing and conducting training courses in scientific writing for agricultural research scientists

Although these guidelines have been developed for scientific writing training courses, the same principles apply to other group training courses. You could therefore modify the details outlined here to design and conduct other group training courses in agriculture.

A1.2 Identification of training needs and objectives

The first step in designing and conducting organising training in scientific writing is to:

– identify the training needs;
– carefully define the objectives.

Training needs can be identified by seeking answers to the following questions:

– Do agricultural scientists in your locality or country recognise the need for training in scientific writing and communication of their research results?
– Are scientists available and willing to be trained in improving their scientific writing and communication skills?
– What are the priority aspects of scientific communication that scientists identify as giving them the greatest problems in their scientific writing and communication efforts?

If the answers to these questions lead to the conclusion that training in scientific writing and communication is necessary:

– What would be the objectives of such training?
– How many agricultural research scientists require training, and how many can you train in each training event?
– What would the training specifically achieve? List your aims.

A1.3 Preparing the training proposal

When you have carefully considered and decided that training is needed, prepare a training proposal that answers the following questions:

– What is the title of the training?
– Why is it needed?

– Who will be trained?
– Who are the primary and secondary target beneficiaries for this training activity?
– What is the training content?
– How, when and where will the training be conducted?
– What resources will be required?
– What expertise will be required to conduct the training?
– What methodology will be adopted?
– What is the expected output?
– How will the training be evaluated?
– What follow-up actions are envisaged after the training?
– What is the overall cost of conducting this training? Prepare a realistic budget.

Write up this proposal and submit it to your colleagues and to your supervisor for their comments. Revise and finalise the proposal before finally submitting it to your supervisor so that the training activity can be scheduled in your institution's annual work plan.

A1.4 Designing and planning training

Plan scientific writing and communication training well in advance, considering the following three major elements.

A1.4.1 Technical content

Determine the general content of the training by organising a technical consultation between the potential trainers, based on considerations of training needs. The technical content should be well focused to address the identified training needs, in order to achieve the objectives of the training.

A1.4.2 Participants

Clearly define the profile of the agricultural research or related scientists who should benefit from the training. Do this by considering and defining participants' selection criteria according to the following:

– institutional affiliation – e.g. government-sponsored national agricultural research system, NGO, agricultural development project, training institution;
– minimum educational and professional qualification;
– age range;
– experience of writing and publishing scientific research papers;
– current work responsibilities;
– participation in related training courses or workshops.

A1.4.3 Training pattern

What pattern will you adopt to conduct the training? Determine the proportion of time to be allocated to the various components of training: lecturettes; hands-on group practical work; group presentations; demonstrations by specialists such as artists, DTP specialists, designers and printers.

A1.4.4 Training environment

Consider carefully the environment where the training will be conducted: the classroom facilities available; the size and flexibility of configuration; access to relevant and adequate technical support.

A1.4.5 Training logistics

List all the logistics needed to conduct the training and how they will be obtained. Logistics include the classroom, participants' accommodation, transportation, secretarial support, catering arrangements and location, and all other facilities that will support conduct of the training.

A1.4.6 Timing

Plan your training at a convenient time for the host institution, the resource persons and the participants. For example, there is no point organising training when the head of the institution hosting the training event and the key support staff will be on leave, and therefore not available to provide administrative and related support for the training.

Based on the training content, determine the duration of the training event to give enough time to cover all the training topics scheduled.

A1.4.7 Funding

Consider carefully all the costs for:

– participants;
– resource persons;
– support services;
– logistics – transportation, etc.;
– publicity;
– materials and supplies.

List them and determine the quantities required, find out their actual costs, and prepare a training budget. Using this budget, source funds from your institution or development partners to conduct the training.

We strongly recommend that you embark on the training event only when you have actually obtained the total amount budgeted for the training.

A1.5 Conducting training

To conduct training successfully, you need to consider and identify the following key requirements.

– Expertise – this includes expertise in agricultural research; writing, editing and publishing scientific papers in scientific journals; design and DTP; and management and evaluation of group training.

– Facilities – the facilities essential for conducting training should be adequate for the number of participants, and provide adequate space for practical working group activities. Select a training centre equipped with presentation facilities, computers, photocopying and efficient secretarial support. Transportation should be available to convey all participants.

– Programme issues – the programme should be designed with a strong emphasis on practical, hands-on working group activities, group discussion and participation/presentation by all trainees. Formal lecturing should be reduced to the barest minimum; a theory/practical time distribution ratio of 30/70% is recommended. Maintain a flexible programme which can be adjusted according to the pattern of participants' responses to the training.

A1.6
Evaluating the
training

Evaluation is an essential aspect of every training event. In scientific writing and communication training, two major aspects are evaluated:

– technical content of the course – this is done in a participatory manner involving the technical resource persons who handled various topics – their coverage of the topics, the pattern of delivery and resource person/participant interaction should be evaluated;

– general management of the training – this includes evaluation of daily training activities, and a general evaluation to assess the extent to which the training objectives were met.

Training course evaluation is usually conducted using an evaluation instrument designed for the purpose; an example is provided below (Instrument 1). You may use this instrument as it stands, or modify it for a more specific evaluation of your training.

A1.7
Instrument 1:
Course evaluation

Circle the score that best describes your assessment of each of section of this training.

The scoring code is as follows:

4 = Very good/excellent

3 = Good

2 = Average

1 = Poor

1. Did treatment of the subject cover all aspects?

      1   2   3   4

2. How do you assess the depth of treatment of the various topics?

      1   2   3   4

3. Was the subject of this training relevant to your work?

      1   2   3   4

4. How useful was this training course to you?

      1   2   3   4

5. How well were the training objectives achieved?

      1   2   3   4

6. How would you rate the presentations?

      1   2   3   4

7. Were the resource persons knowledgeable in their subjects?

      1   2   3   4

8. Were the practical sessions useful?

      1   2   3   4

9. Were the instructions in the practical handouts easy to follow?

      1   2   3   4

10. Did the resource persons encourage feedback and interaction?

      1   2   3   4

11. How would you rate the working group activities?

      1   2   3   4

12. How would you rate the time allocation to each topic?

      1   2   3   4

13. Was the pre-training information and communication adequate?

      1   2   3   4

14. How do you rate the administrative arrangements during the training course?

      1   2   3   4

15. Please list three major weaknesses of this training:

(a)

(b)

(c)

16. Please list three major strengths of this training:

(a)

(b)

(c)

17. Please list five changes or additions that you would like to be made in future training:

(a ....

....

(b) ....

....

(c) ....

....

(d) ....

....

(e) ....

....

18. What is your overall assessment of the training course?

                1   2   3   4

Thank you for taking time to complete this exercise. Please hand your completed evaluation to the course organiser.

Follow-up of training

When participants have completed practical, hands-on training, they should return to their station with a plan for future activities using the knowledge and skills gained from the training. Design an instrument to facilitate preparation of a back-to-office report, and design a simple plan for future activities that you could implement when you return to their station or organisation; an example is provided below (Instrument 2).

Suggested elements of follow-up actions include:

– preparing back-to-office reports;
– presenting the action plan designed, obtaining approval, and implementing the action plan to conduct training for other colleagues in scientific writing and communication.

Preparing follow-up actions

In preparing follow-up actions, trainees should not be ambitious and unrealistic about what can be achieved through their action plans. Remember that your anticipated achievement will depend heavily on:

– the nature of your plan;
– the resources and opportunities available to you;
– the implementation pattern of your plan;
– the effects your actions will have on assisting other research scientists to improve their scientific writing and communication skills and increase their research publication records;
– how the environment in your department supports your efforts.

Making a plan for back-home activities is an innovative way of demonstrating initiative and keen interest in supporting your organisation. Normally the director of your region or district will be pleased to see such a plan and how you intend to implement it.

**A1.8
Instrument 2:
Preparing a follow-up action plan**

At the end of this training, we expect that you will have gained some experience and improved your knowledge and skills in scientific writing and communication of agricultural results. What will you do when you return to your station?

The purpose of this practical exercise is to assist you to plan your future scientific writing and publishing activities.

Read the questions carefully and try to answer them as best as you can. You may use an additional sheet of paper.

Each participant will then be given 5 minutes to present his/her plan to the group.

Time allowed: 45 minutes.

1. Will your head of department or director expect you to present a report on this training course?

Yes   No

If your answer is yes, what will your report contain?

....
....
....
....

If your answer is no, why do you think that a report will not be expected from you?

....
....
....
....

2. List three major objectives of reporting to your director/head of station:

(a) ....
(b) ....
(c) ....

3. How will you achieve these objectives?

....
....
....
....

4. How soon after this training will you write your report?

....

5. Will you write this report alone, or with other participants?

....

6. List the proposed contents of your report in a logical order:

....
....
....
....
....
....

7. What recommendations will you make in your report?

....

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....

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....

....

8. What aspects of your work will be improved as a result of attending this training?

....

....

....

....

....

9. The Participants' Action Plan Approach (PAPA)

Think through the actions you can take, and the time after training in which you can take the actions. List the main actions and timings in a table. Review and discuss this action plan.

Table A1
The Participants' Action Plan Approach

Major action	When I will start to take action (months from date _____)			
	2	**6**	**12**	**18+**
1				
2				
3				
4				
5				
6				

Practical
exercises

A2

Exercise 1 Networking – paired activity
Time allowed: 1 hour

There are two parts to this exercise. The first part should be done individually. In the second part, you should choose a partner and work in pairs.

Part 1

Please write a half-page brief about yourself using the following suggested profile format:

– full name;
– institution;
– full contact addresses: postal, fixed and mobile telephone, fax, email;
– education and professional experience;
– university and related education, working experience, training received;
– professional activities;
– current job responsibilities in relation to agricultural extension, agricultural
  education, farmer training, technical support to farmers;
– hobbies, non-professional interests and activities (e.g. sports, music, climbing
  mountains, religious activities, photography, judo, writing novels).

When you have competed this exercise, please hand over your profile to the course director.

Part 2

Choose your partner to work with and sit together for 10 minutes to get to know one another.

Ask your partner key questions about his/her professional career and interests outside work.

Write down the answers to the questions.

Each of you should now write down five good things about yourself.

Write five good things that you have done for other people (e.g. relations, parents, wife, children) or the community – that you are proud of – during the past 2 weeks.

Exchange these notes and prepare to present your partner to the whole group during the plenary.

Exercise 2 Practical participatory exercise –
what should this training course offer?
Time allowed: 1 hour

Part 1: Training course norms

Turn to your immediate neighbour and talk for 2 minutes, then introduce your neighbour for 1 minute.

What do you not want to happen in the workshop? As a group, list your responses on a flip chart. The charts will be displayed on the walls throughout the training period.

Part 2: Difficulties encountered in writing and publishing research results
Work in small sub-groups. Each group should choose a facilitator.

Consider the most difficult problems you encounter in your efforts to write and publish the results of your research.

Compile two lists: (1) difficulties encountered in publishing journal articles; (2) difficulties encountered in writing and publishing research results for non-technical audiences.

Examine these lists carefully and prioritise the difficulties identified.

Report back your findings in plenary.

Part 3: What do you wish to obtain from this training course?
Again, work in small sub-groups.

What are the most important things that you wish to gain from this training?

What do you expect to be able to do after this training course?

How will participating in this course enhance your capacity to publish research results more effectively?

Report back your findings in plenary.

Exercise 3 Working group activity – the structure of a research paper

The basic structure of a research paper is the IMRAD format:

– Introduction
– Materials
– Methods
– Results
– Discussion
– Conclusion
– Acknowledgments
– References

Study these sections. What major question will each section answer in order to form a logical series? List the question under each section.

What are the major features of each of these sections?

For each section, discuss the major difficulties you encounter in writing this part of the paper. List these difficulties on a flip chart.

For each section, discuss how these difficulties may be overcome. Add these solutions to the flip chart.

Select a member of the working group to present your group report to the plenary.

Exercise 4 Working group activity –
writing in simple and clear English language

Working in your sub-groups:

– Study the following sentences carefully.
– Identify the message intended.
– Make a list of all the things that are wrong with these sentences.
– Rewrite each sentence in clearer English.
– Report back your findings in plenary.

(a) The best pesticide was adopted to annihilate the great pestilence organisms.

(b) The results of the field experimental trials were subsequently subjected to statistical analysis based on the ANOVA system of variables. The significance levels of 5% were achieved; therefore we reached many good conclusions.

(c) The invention and introduction of Information Technology otherwise designated as IT for reporting results of field data from research is a wonderful and terrific invention which makes easy writing of papers for publication and will give the inventors outstanding opportunities to make many financial killings.

(d) Our results from the experimental fields demonstrated that the soil management mechanisms on the basis of Mucuna planting very much depend on various amounts, varieties, and the financial magnitude of the soil amendment products used.

(e) No exploration of this unique possibility has yet been carried out or even investigated.

(f) We studied the nutrient uptake of cabbage crops in the valley slopes of the experimental area and found that even when the substance known as phosphorus was abundant there, only the young cabbage seedlings had the capability of utilising this product, nevertheless we also found that when we grew cabbages with tomato in the same fields, all the crops did very well indeed to give high productivity and yields so we quickly recommended this style of cabbage and tomato production to the benefit of the farming folks.

(g) The statistical analysis showed that the variables were not highly significant.

(h) The milking cows were sent from overseas to our farm.

(i) This field experiment is more difficult and therefore we will need more time

(j) Many of our scientists are very busy women

(k) In the Upper East Region of Ghana high population growth coupled with the impacts of climate and land-use change have led to an increasing demand for water resources. As the yields of rain-fed agriculture are decreasing and become increasingly unreliable a large number of farmers have started to engage in the production of dry-season vegetables. Thereby they are increasing the scarcity of already limited water resources of this semi-arid part of Ghana.

(l) This study is an attempt to address part of the problem highlighted above by assessing water productivity for tomato production under contrasting sources of irrigation supply and management in semi-arid savannah during the dry season.

Gross margins are also estimated for the general understanding on returns per unit land and water in the study area.

Exercise 5 Working group activity – preparing a scientific poster

You have been invited to present a poster at a scientific meeting. You will be provided with computer facilities to prepare the texts and illustrative matter for your posters.

Discuss within your working group and decide on:

– the subject matter for the poster;
– the title;
– relevant text and illustrative matter;
– how the poster will be produced – assign tasks to different members
  of your working group.

Prepare the poster for the critique session of this training course.

Use the following evaluation sheet to evaluate other groups' posters.

Evaluating and scoring scientific posters

Group

Title of poster

Study and review the scientific posters prepared by the working groups.

Pay special attention to, and make notes on, the following aspects. Score each of the following aspects of the poster on a scale of 1–4:

1 = very poor;

2 = average;

3 = good;

4 = excellent.

(a) Physical appearance of the poster: appeal, visual attractiveness

             1   2   3   4

(b) Clarity of design; layout, balance between text and illustrations, selection of font type and size

             1   2   3   4

(c) Sequence of technical information

             1   2   3   4

(d) Technical structure

             1   2   3   4

(e) Technical quality: accuracy of information

             1   2   3   4

(f) Harmony between text and illustrations

          1   2   3   4

(g) Ease of reading and understanding

          1   2   3   4

List the best points of the poster:

....

....

....

List the worst points of the poster:

....

....

....

....

Overall assessment of the poster

          1   2   3   4

Other general comments on the poster presentation

....

....

....

....

Index

Agricultural research in African, Caribbean and Pacific (ACP) countries has been characterised by poor communication and limited use of its results by beneficiaries, perhaps due to limited capacity of researchers in scientific writing and communication of agricultural research results.

This revised edition of *Scientific Writing for Agricultural Research Scientists* addresses practical issues that agricultural researchers face on a daily basis. It aims to give valuable advice and direction to agricultural scientists in the ACP countries, who often grapple with how to write a scientific research paper and get it published. Furthermore, this book addresses the challenge of communicating with non-scientific audiences and informing them about the benefits of investments in agricultural research.

This book is an essential tool for ACP scientists and development workers who wish to develop the culture of scientific writing and communication, so that they can promote the effective dissemination and use of their research outputs.