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Scientific Writing and Communication in Agriculture and Natural Resources

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Preface

It is often said that change is the only constant thing in the world. This maxim is particularly relevant to science. Throughout the history of human development, science has been evolving and generating new knowledge. From prehistoric times, such new knowledge was passed down orally from generation to generation. Domestication of several agricultural crops, for example, predates the development of writing systems. With the advent and development of writing, the storage and communication of knowledge across generations and cultures became much more accurate and convenient. The remarkable advances in technology bred by rapid developments in scientific knowledge and discoveries have resulted in enormous changes in human life and experience, especially during the past 50 years.

One aspect of the scientific endeavor that has perhaps not undergone substantial transformation along with these rapid and astounding changes is the way in which scientific papers are written and presented, i.e., the sequence of steps involved in preparing them. Scientific writing in English is reported to have started in the fourteenth century and scientific communication as we know it today may be a little over 300 years old. The period since World War II has witnessed an enormous increase in the amount of scientific outputs and publications in print versions, and lately in electronic versions as well. The nature or the act of writing has also been constantly evolving with the development of new technologies such as pen, printing press, and computers over the centuries; the change became quite rapid since the relatively recent introduction of digital technologies. All these technological developments have altered the content as well as the medium of writing. Remarkably, however, the sequence of steps involved in writing scientific papers has not undergone any significant changes during this era of rapid progression. Scientific papers—whether published in print journals or online—are still written according to the simple and convincing logic of the IMRAD format (an acronym for Introduction, Materials and Methods, Results, And Discussion: see Chap. 2 of this book) that is said to have been in use for a century. The early career and relatively less-experienced writers will find this constancy in the midst of all the changes happening in science rather comforting in a sense, because while they have to deal with a whole host of intimidating research challenges not experienced by their older peers, they can adopt the same logic and format that their peers have used for writing their papers.

The idea of compiling such a book has been in development for some 20 years. We were fascinated by the informative and entertaining columns that Mr. William Luellen wrote in the 1990s under the general title "Fine-Tuning Your Writing" in the monthly newsletter (then called *Agronomy News,* now *CSA News*) of the ACS societies—the American Society of Agronomy, the Crop Science Society of America, and the Soil Science Society of America (These columns were later published as a book with the same title: Luellen 2001; see References). The first author of this book who was then the Editor-in-Chief of *Agroforestry Systems* as well as an Associate Editor of *Plant and Soil*, and the second author who was an Associate Editor of the *Journal of Environmental Quality*, were benefitted considerably by Mr. Luellen's columns. In 1998, an opportunity to consolidate these benefits with personal experience arose when the first author was invited to conduct two-week training courses on scientific writing at the Forest Research Institute and Colleges in Dehradun, India. That series of lectures and exercises for scientists and professionals of forestry research institutions throughout India provided a motivation to develop an early version of a training manual for scientific writing in agroforestry and natural resource management. Subsequently, we had the privilege and opportunity to deliver various versions of the course to different institutions in a few countries around the world. The second author currently teaches a graduate level course in scientific writing at the University of Florida.

While these activities have enabled us to stay abreast with the developments as well as needs in scientific writing in agriculture and natural resources, we have been constantly reminded about the lack of a manual or aide for helping early career scientists to get started in writing research papers. Perhaps there is no dearth of books, reference manuals, and Internet sources on scientific writing. Given, however, that different fields have different conventions for writing style, we have found it difficult to recommend a specific book or source material as the "go to" guide to young scientists in agriculture and natural resources. Having been involved as authors, reviewers, and editors of various journals and publications during the past few decades, we have come to the conclusion that writing a scientific paper is a tedious task for not only us, but most writers. While that is true even for experienced writers, it is a sort of nightmare for the early career professionals such as students, trainees, scientists, and scholars in agriculture and natural resources, especially when their first language of communication is not English. Their trials, tribulations, and frustrations are compounded by the severe pressure they experience from the increasing importance attached to authoring scientific publications (in English). This book is targeted mainly to that group.

The ten short chapters of the book are organized in four parts. The first, "Essentials for Good Writing," contains four chapters that emphasize the importance of publishing research results, review briefly the various types of scientific publications, give an account of the IMRAD format, outline the essential features of tables and figures, and deal with the use of various issues such as numbers, units, abbreviations, nomenclature, and so on—which we call the "nuts and bolts" that are needed to keep the paper together. Part II that includes two chapters, one each for Words and Sentences, deals with the use and misuse of

English as the international language of science. Manuscript preparation and submission is the scope of Part III. It has two chapters: Chap. 7 describes the essential steps involved and their sequence in preparing a manuscript and Chap. 8 outlines the common procedures to be followed in submitting a manuscript to the journal and following it up through the peer-review process and the ensuing communications. The last part, Part IV, of the book is about communication of research results through oral and poster presentations, with a chapter each on these two forms of presentations to the peer groups at conferences and meetings. A list of references and recommended reading completes the book.

We have drawn from and consulted various sources for compiling this book. In fact such a book that contains materials and expressions used for a long period of time cannot be prepared in isolation, and from that perspective cannot be claimed to be truly "original." But in light of our experiences, we have adapted, modified, paraphrased, and contextualized the various expressions and usages to the specific needs and requirements of writing focused on agriculture and natural resources—primarily in the biophysical areas. In doing so, we have found some publications and sources particularly useful; these include: Day (1988), Luellen (2001), Malmfors et al. (2004), Stapleton et al. (1995), Stilman (1977), Strunk and White (2000), and Wikipedia (www.wikipedia.org). All these and other references and sources consulted are listed in the section "References and Further Reading."

The inspiration and encouragement for undertaking such an effort came from the innumerable colleagues, trainees, students, and visiting scholars from around the world over the years. In addition to thanking all of them, we would like to express our special thanks to Gregory Toth, Ph.D. candidate, and Rekha Nair, Ph.D., for critically reviewing the chapter drafts and offering many suggestions for improvement from the perspectives of early career professionals.

A final word: this is not a "rule book." The "rules" for publishing are set by journals and publishers. Please follow them. What we provide in this book are only some guidelines, which, we think based on our experience, are widely applicable and will help in the preparation of manuscripts according to the journals' instructions. We earnestly hope that the current and future generations of readers will find the book useful.

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Part I
Essentials for Good Writing

Chapter 1
Introduction

Abstract Communication is crucial to the development of science. A research project is not complete until its results are properly disseminated. The most recognized way of doing that is through well-presented research publications. Scientific publishing is a rigorous, highly competitive, and disciplined activity with well-structured codes of conduct. In order to get published in good-quality journals, the manuscripts must be prepared well. The most recognized type of scientific publication is the research paper in a peer-reviewed journal; others include review papers, book chapters, conference presentations, and abstracts. Science is international and the knowledge communicated through scientific papers should be of universal application; however, popular science writing has a valuable role in communicating research results, especially in application-oriented disciplines such as agriculture and natural resources.

1.1 Scientific Writing: A Brief Overview of Developments

Scientific communication as we know it today may be a little over 300 years old. It was in 1665 that, coincidentally, both the *Philosophical Transactions of the Royal Society of London*, England, and the *Journal des Scavans* in France, the two first "journals," commenced publication (Day 1988). Despite these early beginnings, scientific publishing did not attain prominence until after World War II when "massive" investments in research led to "massive" production of research papers. Faced with the pressures of coping with a phenomenal increase in publishable research and given the preeminent status of journals as the primary means of communication of research results, new scientific publishing enterprises were started and the journal editors began to develop and implement tighter and stricter publishing norms and quality control standards. These developments demanded that manuscripts be tightly written, well organized, and prudently peer-reviewed—which

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continue to be the foundations of scientific publishing today. This trend was particularly true for agricultural sciences concurrent with the Green Revolution of the 1970s. With the cooperation of publishers, editors, and authors, scientific publishing has thus became a rigorous and disciplined activity with well-structured codes of conduct—both written and unwritten. Thanks to the proliferation of online journals during the past decade, today we are witnessing yet another significant development in the history and development of scientific writing and publishing.

1.1.1 The Importance of Writing and Writing Well

Communication is crucial to the development of science. We know about the work of all the great scientists because they published their results. Writing or talking about the research helps us to clarify our thoughts and present the research in a wider context. Thus, communication of research results is an integral part of the research process. Indeed, a research project is not considered to be complete unless its results are properly disseminated. The most recognized way of doing that is through well-presented research publications.

The "Publish or Perish" aphorism and its corollary "Publish and Prosper" have been around for quite some time in scientific professions. In the authors' own experience, that was the rule 40 years ago, and that—indeed in a more stringent form—is the rule today as well, and is now followed more strictly and in more countries and organizations than ever before. Scientists of all categories are under increasing pressure to publish for career prospects and professional recognition; this is particularly true for those in their early career stages. Publishing research results is also important to the community of scientists for the advancement of knowledge in the discipline. Furthermore, considering that most of the research is supported by public funds ("tax-payers' money") and scientific publications are the primary or immediate product or output of most research, scientists have a responsibility to publish their results to fulfill the obligation to the society at large in terms of accountability of (public) research funds.

Getting published in good journals is a highly competitive endeavor. Most journals and other publication outlets receive more papers than they can publish; the more prestigious a journal is, the higher the number of submissions received and rejected by it. Poorly written papers are the first ones to be rejected. Good writing is also an essential aspect of "marketing" your research. In order to market any product, style is as important as substance. Good packaging cannot make up for poor content; but poor packaging can mask the quality even if the content is good. Indeed, like most other long-term editors and reviewers, the authors too have had the very unpleasant task of rejecting or recommending rejection of manuscripts because of their poor quality of writing and presentation. The phenomenal developments in electronic publication have remarkably expanded the opportunities for publishing; however, good-quality journals are still highly sought after, and publishing in such journals has only become increasingly challenging.

Moreover, readers today have relatively easy access to an enormous array of publications, such that if an article is to be read and cited—i.e., recognized—it must be presented well. Editors are therefore forced to accept only well-presented articles. The bottom line is that scientists must endeavor to write and publish well.

1.1.2 Scientific Methods, Scientific Papers, and Popular Science Writing

Science is all about the pursuit of knowledge. As human beings, we all are entitled to our own opinions on any subject, but we are not entitled to our own facts. A fact is truth as we know it, and it is through scientific methods that we discover truth. A scientist will develop a null hypothesis about how something works based on observations and current state of knowledge about it, then perform an experiment, analyze the data, and reject the null hypothesis. The scientist, being a skeptic, does not "accept" the null hypothesis, but, based on data analysis, either rejects it or fails to reject it. Over time as the experiments are replicated and the longer it takes to "fail to reject" the null hypothesis, it becomes a theory of how things work or truth as we can best know it. The scientist then writes up these results and interpretation as a paper and submits it to a scientific journal. The paper is then reviewed by other scientists who are experts in that field. They examine the experimental design, the methodology, the data collection, the statistical analysis, the conclusions derived, etc., and if everything meets their criteria, the paper is accepted for publication. It is in these peer-reviewed scientific journals that the "body of truth as we know it" for humankind exists. This system may not be perfect; but humans have not been able to come up with a better one to describe any phenomenon and build a body of truth (facts) to explain it.

Science can be communicated in various ways to different audiences. The method that is most recognized by the scientific community for communication of new research results to fellow scientists is a paper in a scientific journal. As mentioned earlier, results of scientific research also need to be communicated to the general public to meet the accountability standards for using public funds. Moreover, newspaper journalists, TV talk show hosts, political leaders, other community leaders, etc., who are influential with the general public need to be informed about the results of scientific research and their ramifications. "Popular science writing" refers to writing for such non-specialists using a language that is easily understandable by readers who are not specialists in the discipline.

Both forms of writing (scientific papers and popular science articles) must fulfill the so-called ABC of communication (accuracy, brevity, and clarity). Being targeted to different readers, they have different organizational style and format ("language"). While scientific papers present new knowledge that has been generated by accepted, rigorous procedures of investigation and approved to be publishable by independent and competent subject-matter specialists (reviewers), popular science articles present the knowledge that is contained in scientific

research papers for the understanding of the general public to arouse interest in and educate the reader about the new developments. Tables and figures are commonly used to present new knowledge in scientific papers, whereas illustrations and examples are used more often in popular science articles to facilitate reading and understanding. The reliability of the information presented is a crucial feature in both forms of writing.

The main focus in the subsequent sections of this publication is to explain how scientific research papers should be organized to meet the demands and norms of scientific publications.

Why should scientists write research papers?

- Communicate with fellow scientists
- Help advance knowledge in the field
- Support progression of professional career
- Satisfy the donor
- Become famous and respected

Why is good writing important?

- Writing is highly competitive
- Market your product: Style is as important as substance
- Journals receive more papers than they can publish
- Poorly written papers will be the first ones to be rejected

Scientific papers and popular science writing

- Scientific papers are published in peer-reviewed research journals for the community of scientists
- Popular science writing: for readers who are not specialists in the discipline.

1.2 Scientific Publications

A scientific publication is a document—in "hard" (paper) or "soft" (electronic) form—that reports the results of original research. Research (noun) as defined by the Oxford English Dictionary is the *systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions*. The Merriam Webster Dictionary explains research as *careful or diligent search, especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or*

practical application of such new or revised theories or laws. A scientific paper is a valid and permanent publication that presents results of an original investigation and adds to the previous state of knowledge in such a way that potential users can assess the observations, repeat the experiments, and evaluate if the conclusions are justified by the data.

Given that the investigations can be of a wide and varied nature, the publication of the results can be of various types. New results are often first communicated to other scientists at a conference in oral form or as a poster presentation (see Chaps. 9 and 10). Although abstracts of such presentations will be available to fellow scientists, they do not become recognized as full research publications until they successfully undergo rigorous peer review and meet the style and formatting criteria of journals. For that reason, the most widely recognized form of a scientific publication is a paper in a research (peer-reviewed) journal. Before going into the details of the nature and requirements of a research paper, let us briefly consider the nature of common scientific publications.

1.2.1 Research (Journal) Paper

Research journals publish new and original research results and are the most widely recognized type of research publication. Papers published in these journals present new knowledge that has been generated by accepted, rigorous procedures of investigation. The most common form of a research paper involves a hypothesis that is tested by accepted experimental methods leading to well-founded conclusions. Journals have specific policies and criteria for accepting articles for publication; however, all follow the peer-review system by which the manuscripts submitted for publication are reviewed by independent, competent authorities in the subject, based on whose recommendations the editor makes the decision to accept or reject the manuscript.

1.2.2 Review Paper

Reviews present the state-of-the-art or cutting edge of knowledge on the chosen subject. These include authoritative discussion by competent research leaders in the subject. A review paper synthesizes and evaluates reported results by analyzing and interpreting the findings in a specific field, and often identifies future directions in research. The review paper, however, is based on papers and information that *have already been published*, yet the stigma of dual publication does not arise because the review nature of the paper is made obvious in the title of the paper and/or the journal that publishes it (e.g., *Annual Review of Plant Biology*).

1.2.3 Book Chapter

These are somewhat similar to research reviews. Various types and forms are available depending on the scope of the book of which the chapter forms a part.

1.2.4 Conference Paper and Abstracts

A conference paper that presents the results of research in a professional conference is often the first step in communicating research results before a paper is ready for submission to a journal and peer review. Following discussion in the conference, the paper may be improved and published in the conference proceedings, or developed further into a full journal paper. Conference Abstracts, as the name indicates, are abstracts of conference papers that may or may not actually be presented at the conference, and are included in the book of abstracts that some conferences publish in print for limited circulation or online, which is the current trend. But such abstracts are often written several months ahead of the conference and therefore may not contain the full body of results that will be presented at the conference. Thus, the abstracts are ephemeral in nature and are not rated as high-quality research publications; some journals do not even allow such abstracts to be cited as valid literature citations in manuscripts.

1.2.5 Theses and Dissertations

These are written documents of sustained research conducted by graduate students for periods from two to four or more years, and are presented in descriptive style with elaborate literature review. They will result in various types of publications such as journal papers, review articles, and conference papers.

The words "thesis" and "dissertation" are used differently in the US and other parts of the world. In the US, a thesis refers to a research document for the Master degree and the dissertation for the doctoral degree (Ph.D.), whereas in Europe and some other parts of the world, a thesis is often submitted for a Ph.D. degree and a dissertation for a Master degree; there are also undergraduate (Bachelor degree) theses/dissertations in some places.

1.2.6 Short Communication/Research Note

Some journals allow publication of incomplete or initial results as Short Communications or Research Notes. The objective is to disseminate interesting trends and results that have not yet been conclusively proven. Short communications are prepared in the same format as research papers, but every section is shorter than the corresponding section in a research paper.

Some journals also publish readers' responses to research papers and authors' rebuttal to such responses, both of which are considered scientific publications.

1.2.7 Monograph

A monograph provides an authoritative account of a research topic, and is often much lengthier than research articles or review papers. Some monographs may contain results of specific investigations, but mostly they provide a synthesis of several years of work on a specific subject over a long period of time by one or a group of experts.

Overall, journal papers have the highest ranking in terms of technical content, value, and recognition. The relative ranking for other types of research publications is variable depending on a number of factors such as the type of journal or other publication in which they appear, if they are peer-reviewed, and so on.

Types of Scientific Publications

- Research (Journal) Paper
- Review Paper
- Book Chapter
- Conference Paper/Abstract/Poster
- Thesis/Dissertation
- Short Communication/Research Report
- Monograph

1.3 Journal Articles and Location-Specific Research

Science is international, and the knowledge communicated through scientific papers should be of universal application. Some explanation, however, is needed here about the universality of results based on location-specific research and their application to agriculture and natural resource management.

1.3.1 Basic and Applied Research

Research, as described earlier, involves *investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or law…* Within the limits of these attributes, a distinction can be made between **basic** and **applied** research depending on the nature and scope of research. Basic

or fundamental research investigates processes and mechanisms; research dealing with such issues as DNA and fundamental processes of nitrogen fixation or photosynthesis falls under this category. The objective of basic research is advancement of knowledge, not necessarily direct application of the results. Results of such research may eventually be widely applicable with far-reaching consequences; but that is an after-effect, not an objective. Applied research involves application of research results to solve specific problems. Sometimes two categories of applied research are recognized in agricultural sciences: strategic and adaptive. Strategic research refers to innovative application of basic-research results to solve practical problems in the medium-to-long term. An example is the development of dwarf cultivars of cereals especially rice, maize, and wheat through the application of advances in basic research disciplines such as plant physiology and genetics. Adaptive research, on the other hand, refers to development of location-specific technologies for solving practical problems of an immediate nature; the use of agroforestry technologies for soil conservation in a specific location is an example. Sometimes strategic research is described as an interphase between basic and applied research.

1.3.2 "What," "Why," and "How" Types of Research

Another perspective of basic and applied research that is quite relevant to research (and therefore research publications in agriculture and natural resources) is the nature of questions addressed in research: "**what**", "**why**", and "**how.**" "What" type of research is mostly observational in nature; for example, what happens if a tree is pruned according to a particular schedule or what happens if a crop is grown in association with a tree. The results obtained from such trials are highly site-specific. "Why" type of research tries to discover the reasons for the observed behavior; for example, why do crop yields decline over successive years when grown without external addition of nutrients (fertilizer application) on a site that is cleared from forest? "How" type of research tries to find out how a given phenomenon happens, including how could it be different from what has been observed. For example, how do trees improve the fertility of soils beneath them? The "what" type of research alone, being mostly observational in nature, does not provide the elements of understanding needed in a research paper, and is only used to set the stage for the "why" and "how" types of research.

Many field investigations in applied sciences, including surveys, are limited to finding out "what happens when something is done": planting trees and crops together in certain combinations, using tree-biomass as nutrient source for crops, collecting farmers' perceptions on some issues, and so on. The data are then analyzed using statistical packages, and papers are written to report that one treatment was better or different from another, farmers did not like a particular technology, and so on. These are examples of the "what" type of research: what happens when something is done. Even if the research is repeated for several seasons, the result

will be of the same nature, and the unasked questions will, naturally, remain unanswered. These results might, at best, be applicable to the specific location where the study was conducted, but has uncertain applicability at locations with different biophysical and socioeconomic characteristics. The importance lies in identifying the "right" questions and establishing clear objectives before the research is undertaken. If the research were planned to answer the questions "why" and "how" did things happen the way they did, the results would be more widely applicable. In other words, research should be aimed at establishing cause–effect relationships and exploring the principles that form the basis of observed behavior.

A practice cannot surpass principles. Often times, the effort needed to do the "how" and "why" type of research is not much more than that for the "what" type of research. For example, in a study to compare the *Leucaena leucocephala* and *Calliandra calothyrsus* as sources of biomass for crop nutrition, just reporting that one species was better than the other would not be a publishable research paper. On the other hand, supposing the research showed that the biomass of the two species were different in, say, tannin content, and therefore they decomposed and released nutrients at different rates, that reasoning will have relevance in a much wider context than at the place of study. A paper reporting that as the reason for the differences in response to the two sources of biomass will have more scientific value, and therefore have a much better chance to be acceptable to the journal, than the one that simply reports that one species was better than the other. Another example of this nature could be just reporting that the pattern of nutrient-uptake from one location was different from that in another location instead of reporting that observation and explaining the reasons for that result based on experimental data collected from those locations. Thus, when the research is planned to be application-oriented, that does not mean that the objective should be limited to just reporting what is observed; it should aim at explaining what is observed based on known facts (or new theories), and be designed to provide such facts needed to explain the results.

1.3.3 Location-Specific Research

The various categories of research in agroforestry are not too different from those in other land-use disciplines such as agriculture and forestry. Nevertheless, experimental approaches in agroforestry merit a special mention. As described by Nair (1993) and others, these land-use systems are usually more complex than agriculture and forestry. They embrace multiple species and combinations of widely different components, with special emphasis placed on exploiting the ecological and economic interactions between the components. Outputs, either as products or services, are more numerous, and these systems conceivably offer a higher degree of soil sustainability than is usually found in agriculture. Understandably, these complexities and attributes add a different dimension to agroforestry experimentation. Only those types of research that can produce results of immediate practical

applications in the shortest time possible and in the most cost-effective way are perceived as justified and supported in agroforestry and such other land-use disciplines by policy makers and donor agencies. It is then clear why applied research involving field trials and experiments are the most preferred form of research in these disciplines. Although such field trials can involve investigations at an ecosystem level, the term usually refers to investigations undertaken on research stations, farms, or other relatively small field units. Thus, most (if not all) agroforestry and related land-use system research is application-oriented in nature (as opposed to basic: the proverbial "Newton's apples and Darwin's finches"). The results of such investigations have a high level of location-specificity (i.e., valid for only the location where the study is conducted). The intellectual challenge of the scientist is to explain the scientific basis for the observed results and thus make the results applicable to a broader context than the study location. Manuscripts that do not provide this sort of analytical insight and reasoning based on theoretical foundations and experimental evidence do not contribute to the knowledge base and may not pass the review process. This is a common reason why many agroforestry research manuscripts do not pass the review stages of high-impact journals. Researchers need to be aware of these issues and should set the objective clear and focused right at the planning stage of research; once the study is under way, it would be too late to rectify the planning-and-design deficiencies of the experiment.

Types of Research, based on

Application of Results

- Basic: Pursuit of knowledge; not motivated by potential for immediate application
- Applied: To solve problems
  - Strategic
  - Adaptive

Nature of Questions Asked

- What: What happens when it is done the way it is done?
- Why: Why does it happen so?
- How: How does it happen so?

Location-Specific Research

- Common in agroforestry
- The results can be applicable to a broader context than the study location by explaining the scientific reasons for the observed behavior
- Set the objectives right while designing the experiment, and use proper methods for fulfilling the objectives.

Chapter 2
Organization of a Research Paper: The IMRAD Format

Abstract Most scientific papers are prepared according to a format called IMRAD. The term represents the first letters of the words Introduction, Materials and Methods, Results, And, Discussion. It indicates a pattern or format rather than a complete list of headings or components of research papers; the missing parts of a paper are: Title, Authors, Keywords, Abstract, Conclusions, and References. Additionally, some papers include Acknowledgments and Appendices. The Introduction explains the scope and objective of the study in the light of current knowledge on the subject; the Materials and Methods describes how the study was conducted; the Results section reports what was found in the study; and the Discussion section explains meaning and significance of the results and provides suggestions for future directions of research. The manuscript must be prepared according to the Journal's instructions to authors.

An important point to keep in mind is that there is no standard or uniform style that is followed by all journals. Each journal has its own style; but they all have their own Instructions to Authors (or other word combinations to mean the same thing). Once you select a journal to which you wish to submit your manuscript, please FOLLOW THE JOURNAL'S INSTRUCTIONS TO AUTHORS, which can usually be found in each volume of the journal (note that a volume may contain several numbers, and there could be multiple volumes in a year), or easily accessed from the journal's webpage. Some authors may not be fully convinced about the logic of some of these instructions, but it is a futile effort to argue with the journal or complain about its instructions. Remember that authors are free to choose from a number of journals in which to publish their papers.

Most scientific papers are prepared according to a standard format called IMRAD, which represent the first letters of the words Introduction, Materials and Methods, Results, And, Discussion. These do not represent the complete list of headings or components of research papers; the missing parts are: Title, Authors,

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Keywords, Abstract, Conclusions, And References. Additionally, some papers include Acknowledgments and Appendix (Appendices). Sometimes, some sections might be represented and/or amplified by others; e.g., "Theory" instead of Materials and Methods. Other modifications include combining Results and Discussion into one section, and including "Conclusions" as the last part of Discussion. A recent trend is to give only the main aspects of the paper and post all the additional or "less important" aspects as "Supplemental Materials" on the journal's website. Review papers do not have "Results and Discussion," and they usually use other headings instead of IMRAD headings. The term IMRAD indicates a pattern or format more than the words covered by the abbreviation. With the American National Standards Institute (ANSI) adopting the term as the standard, first in 1972 and again in 1979 (ANSI 1979), it has become the choice of most research journals.

2.1 Title

The title of the paper will be read more than any other part. The way in which a paper is "browsed" by readers is in the order: Title—Abstract—Results (Tables and Figures)—Full paper. The prevailing trend is said to be that, on average, the number of readers from one section to the next in the above sequence decreases by a factor of 10. That means for every 10 readers who look at the title, one reads the Abstract; for every 10 who read the Abstract, one goes to the Results section, especially Tables and Figures; for every 10 who read the Results, one reads the full paper. Thus, for every person who reads the full paper, 1,000 read the title. Titles are read both by scientists scanning the contents of a journal and by those depending on searches through secondary sources, which always carry the title and author but may or may not carry abstracts. The title may be reprinted in bibliographies and subject indexes, stored in bibliographic databases and cited in other articles. Therefore, the title is an extremely important component of the paper. A good title will attract readers who might not otherwise read the paper and may help future researchers find important information.

A good title of a research paper should:

- Contain as few words as possible: many journals limit titles to 12 words
- Be easy to understand
- Describe the contents of the paper accurately and specifically
- Avoid abbreviations, formulas, and jargon
- Not include any verb
- Not contain low-impact words such as "Some notes on …," "Observations on …," "Investigations on …," "Study of …," and "Effect of …"
- Not be flashy as in newspapers (e.g., avoid statements like "Agroforestry can stop deforestation")
- Report the subject of the research rather than the results
- Follow the style preference of the target journal.

As Nair (2005) argues, a title such as "Plant species found in homegardens in *region A of country B*" was probably appropriate for an article some 20 years ago, but it is uninspiring to a demanding reader today. The readers know that homegardens involve multiple species, and if they know the location of the study site, they can "guess" the species that are likely to be present there. But, if the title suggests an innovative investigation such as "Does nearness to markets affect species composition of homegardens?: A case study from *region A of country B*" or "Species richness and diversity in homegardens: a boon or bane?" it has a much better chance to attract the attention of the discerning, busy reader.

An important point to remember is that the title, being the first part of the paper, will be browsed by the busy reader, and therefore must be neat, crisp, and coherent to attract the reader's attention. The important words should be placed first and appropriate words should be used to highlight the significant content of the paper. The words chosen should also be in a form suitable for abstracting and indexing services. Jargons and abbreviations should be avoided and, to the extent possible, common names instead of the Latin names of plants (and other living organisms) should be used in the title.

It used to be a common practice to publish a series of papers on a subject with a main title and several individual papers with separate sub-titles, often designated as parts 1, 2, etc. (example: Biomass decomposition in tropical alley cropping: Part 1, Part 2, …). This practice caused several difficulties. For example, the continuity of reading is seriously hampered when different parts of a series are published in different numbers or volumes of a journal or in different journals, or worst, when one or more parts never get published. Such individual parts of a series of papers do not fulfill the essential requirement that each paper "should present the results of an independent, cohesive study" as stipulated in the Instructions to Authors of most journals. Therefore, the series of papers is now not favored by most journals (Day 1988).

A modification of the series is the "hanging title," which is similar to the series title except that a colon replaces the Roman numeral indicating the part of the series (e.g., Biomass decomposition in tropical alley cropping: comparison of common multipurpose trees); this practice is still accepted by most journals. An advantage of the hanging title is that the most important words of the title could be presented first, and could therefore be an advantage to the reader. Some authors, in an effort to beat the journal's strict word-limit for titles, argue that the hanging title be not counted for the title word count. That will be the editor's decision.

Most journals allow and ask for "Running heads." A running head for a paper is an abbreviated title that will be printed as a header on all or alternate pages. The journal's instructions will specify the nature of running heads and the maximum number of characters, including spaces, allowed. The author should make sure that the running head is appropriate to the article in terms of its contents, especially for review papers and book chapters, where the running head should attract the browsing reader's attention.

2.2 Authors

The authors of a paper are individuals who have made an important contribution to planning and carrying out the research reported, and anyone listed as an author should also have helped in the preparation of the paper. Technicians and other helpers are usually mentioned in the acknowledgments.

The authors are listed in the logical order of importance of their contribution to the work. The person listed first is considered the senior author (unless otherwise specified); others may be listed according to the importance of contribution to the effort. Listing authors in alphabetical order is an old practice that is not followed by journals anymore. It is customary to list the graduate student whose thesis or dissertation forms the basis of a paper as the first author followed by his or her major supervisor as the second author. In some disciplines, however, the major supervisor of a graduate student whose research is published is listed as the last author. The person to whom correspondence concerning the paper may be addressed is marked by an asterisk or some other notation.

Author line-up (who and in what sequence) can be a thorny and contentious issue leading to awkward battles and breach of the high ethical standards that scientists are expected to uphold. Sometimes, the head of a laboratory or institute where the work was done may insist to be listed as an author of all papers coming from the organization. Although this is an objectionable practice, if it has to be done, that person should be listed as the last author. Also, it is not uncommon that some exchange visitors (trainees, exchange scholars, etc.) to overseas institutions publish papers upon their return to home institutions, based on their overseas work, listing their foreign supervisors as coauthors without the knowledge and approval of the latter. In order to avoid such situations, most journals require the final approval of each coauthor before the paper is published.

Author names should be complete enough to ensure proper identification, and be followed by an address including email, presented according to the journal's style. The institution to which the author was attached when the work reported in the paper was conducted should be listed against the author even if the author has left the institution after completing the work (which is common for graduate students and trainees); in such cases, the author's current address could also be listed and properly identified.

2.3 Keywords

These are words by which the paper should be indexed by abstracting services. Words that appear on the title should not be repeated as keywords because titles and keywords are listed together by abstracting services. Most journals allow not more than six keywords; some journals do not allow any keywords; and some journals allow a string of several words as keywords. In any case, the keywords

should be specific to the article; common words such as plants, soils, models, and people are too general to be of any value as keywords.

2.4 Abstract

An Abstract is a mini-version of the paper (Day 1988). The American National Standards Institute says "A well prepared abstract enables readers to identify the basic content of a document quickly and accurately, to determine its relevance to their interests, and thus to decide whether they need to read the document in its entirety" (ANSI 1979). Therefore, it is extremely important that the Abstract be written clearly.

The abstract should be *definitive* rather than *descriptive*; i.e., it should give facts rather than say the paper is "about" something. Since an abstract will usually be read by an average of 100 times more people than will read the full paper, it should convey the information itself, not just promise it (Luellen 2001). For example, avoid phrases such as "… are described" or "… will be presented" in an abstract; instead, describe them, present them (except in Abstracts for conferences or annual meetings, written several months in advance of the event). As Ratnoff (1981) stated, "Reading a scientific article isn't the same as reading a detective story."

Journals have strict limitations on the length of abstracts, usually in the range of 150–250 words, and written in one paragraph (multiple paragraphs for review papers). The Abstract should stand on its own, i.e., be complete in itself. It starts with a statement of rationale and objectives and reports the methods used, the main results including any newly observed facts, and the principal conclusions and their significance. If keywords are not listed separately, the Abstract should contain the keywords by which the paper should be indexed. Because the Abstract is a short version of the full paper, it contains a mixture of tenses representing the tense used in reporting the respective sections of the paper. Thus, in the Abstract, statements referring to the rationale and introduction, interpretation of results, and conclusions are in present tenses, whereas materials and methods and results are in past tense.

The Abstract should ***not*** contain:

- Abbreviations or acronyms unless they are standard or explained
- References to tables or figures in the paper
- Literature citations
- Any information or conclusion not in the paper itself
- General statements
- Complex, winding, verbose sentences.

Furthermore, in order to facilitate smooth reading, excessive quantitative data with statistical details and long strings of plant names should be avoided in the Abstract. Experienced writers prepare or fine-tune their title and Abstract after the rest of the paper is written.

2.5 Introduction

A good introduction is relatively short. It tells why the reader should find the paper interesting, explains why the author carried out the research, and gives the background the reader needs to understand and judge the paper.

Specifically, the Introduction defines the nature and extent of the problems studied, relates the research to previous work (usually by a brief review of the literature clearly relevant to the problem), explains the objectives of investigation, and defines any specialized terms or abbreviations to be used in what follows. Remember that the Introduction leads logically to, and clearly states, the hypothesis or principal theme of the paper.

The Introduction should be relatively brief; most journals recommend less than 500 words. Avoid repetition: do not repeat the Abstract in the Introduction (and Introduction in the Discussion). Do not go into an extensive literature review; two to four most relevant and recent citations should be adequate to corroborate a statement. Do not repeat well-known facts nor state the obvious. For example, it is disappointing that even now, i.e., after more than 30 years of concerted efforts in scientific agroforestry and a large volume of literature in the subject, some manuscripts—and, interestingly, some editors—insist on providing a definition of agroforestry in any article on that subject! The Introduction section also may use different tenses: justification and motivation of the study is presented in present tense ("Soils store relatively large amounts of carbon in terrestrial ecosystems."), whereas the review of literature is presented in past tense ("Studies showed that …"), or in present perfect tense if it is common knowledge ("Studies have shown that …"). The objective is written in past tense ("The objective of the current study was …"). Different journals follow different norms and styles. Some want discussion of literature in the Introduction while some want it in the Discussion section. Some journals require a brief account of the Materials and Methods to be included in the Introduction section, and some may want even the important conclusions presented in the Introduction section, although that tendency is now disappearing.

2.6 Materials and Methods

The purpose of this section is to present in a simple and direct manner what has been done, how, and when, and how the data were analyzed and presented. This section should provide all the information needed to allow another researcher to judge the study or actually repeat the experiment. The simplest way to organize this section is chronologically; include all necessary information, but avoid unnecessary details that the readers are supposed (ought) to know.

The section should include the following though not necessarily in this order:

- Description of the study location (climate, soil—by US Soil Taxonomy and/or FAO system, vegetation, etc., to the extent such information is relevant to the study)
- Design of the experiment with number of replications and sampling procedures used
- Plants or animals involved, with exact descriptions (genus, species, strain, cultivar, line, etc.); include Latin names in italics, even for common plants, upon first mention in text (e.g., maize or corn, *Zea mays* L.)
- Materials used, with exact technical specifications and quantities and their source or method of preparation. Generic or chemical names are better than trade names, which may not be universally recognized. Some journals as well as companies require that the company's name is included in parentheses after the material is mentioned
- Assumptions made and their rationale
- Statistical and mathematical procedures used to analyze and summarize the data.

Methods followed should be described, usually in chronological order, with as much precision and detail as necessary. Standard methods need only be mentioned, or may be described by reference to the literature as long as it is readily available. Modifications of standard techniques should be described. If the method is new it should be described in detail. Do not include excessive description of common procedures. Keep in mind and respect the general level of the readers' understanding and familiarity with your procedures. For example, in a manuscript for a journal targeted at researchers in biophysical aspects of agroforestry, it is not necessary to narrate all minute details of how sampling materials/sites were selected, and how samples were drawn and prepared for analysis, and so on. Remember, however, that the journal's editors may ask for additional details of any item.

Special attention may be paid to ensure that:

- Ambiguities in abbreviations or names are avoided
- All quantities are in standard units
- All chemicals are specifically identified so that another scientist can match them exactly in repeating the work
- Every step is explained, including the number of replications
- All techniques are described, at least by name if they are standard, or in as much detail as needed if you have modified a standard technique or devised a new one
- Irrelevant and unnecessary information that does not relate to the results or confuses the reader is avoided.

The Materials and Methods section is presented in past tense. There is no standard "rule" on the use of active or passive forms ("I/we took ten samples" vs. "Ten samples were taken"); follow the journal's norms, and if the journal is not strict about it, use your personal preference.

The SI system (*Le Système International d'Unités*) is used for reporting measurements in all research publications. But this general rule has some exceptions especially when it comes to applied disciplines such as agroforestry. For example, in scientific publications with a regional focus, locally popular, non-SI units may be used if that would help clarify interpretation or understanding of the data, but such units should be explained in relation to SI units at their first mention in text (see Sect. 4.2 for more on the use of units).

2.7 Results

This section presents the new knowledge; therefore, it is the core of the paper. Note that the Introduction and Materials and Methods sections are needed and designed to say why and how the author/s arrived at what is presented in this section, the meaning of which will then be explained in the Discussion section. Thus, the value of the paper depends on what is contained in this (Results) section, and it must be presented in an absolutely clear manner in just the right number of words, neither more nor less. It is usually easiest to follow the results if they are presented in the same order as the objectives are presented in the Introduction.

Some guidelines on presenting the results are given below:

- Present the results simply and clearly
- Report only representative data rather than (endlessly) repetitive data
- Do not report large masses of data; reduce them to statistically analyzed summary forms and present in tables or figures along with essential statistical information to facilitate understanding and comparing them
- Repeat in the text only the most important findings shown in tables and graphs; in other words, do not repeat in the text all or many of the data presented in tables and figures
- Include negative data—what was *not* found—only if useful for interpreting the results
- Cite in the text every table and figure by number
- Include only tables and figures that are necessary, clear, and worth reproducing
- Avoid verbose expressions: e.g., instead of saying "It is clearly shown in Table 2 that the presence of tree canopy reduced light transmission to ground …," say "Light transmission to ground was reduced by the presence of tree canopy (Table 2)."

Tables and figures are an integral part of a well-written scientific paper, and they appear in the Results section (but there are exceptions). While tables present accurate numbers, figures show trends and features. Do not present the same data in tables and graphs.

More on tables and figures are presented in Chap. 3.

2.8 Discussion

This is the section where the authors explain meanings and implications of the results. The section pulls everything together and shows the importance and value of the work and is therefore the most innovative and difficult part of the paper to write. The authors' skill in interpreting the results in the light of known facts and using the results as evidence for innovative explanations of the observed behavior should push the frontiers of knowledge and arouse the readers' enthusiasm. Without such an engaging discussion, the reader may leave saying "So what?" and move on to other, more interesting papers.

A good discussion should:

- Not repeat what has already been said in the review of literature
- Relate the results to the questions that were set out in the Introduction
- Show how the results and interpretations agree, or do not agree, with current knowledge on the subject, i.e., previously published work
- Explain the theoretical background of the observed results
- Indicate the significance of the results
- Suggest future research that is planned or needed to follow up
- Deal with only the results reported in the study
- Stay away from generalizations and conjectures that are not substantiated by the results presented
- State conclusions with evidence for each.

The Discussion section is written in both present and past tenses. Current knowledge (from literature) is stated in present tense, whereas the work being reported and discussed in the paper (your own work) is presented in past tense; e.g., "Treatment A was better than Treatment B, which suggests that …."

Mismatch between stated objectives and discussion/conclusion is a very common problem in many manuscripts. Analytical insight is what we should strive for in the Discussion section, but unfortunately, it is difficult to describe how to accomplish that. Lack of such insight is evident when authors simply state—often repeat—the results, and make superficial statements such as "this work agrees with the work of author X (some unknown author's work, published several years earlier)" as though the objective of research was to see if the results agreed with some other author's (obscure) work published 20 or more years earlier.

Another common problem in Discussion sections is the tendency to move away from the stated objectives and try to "solve all problems." Admittedly, agroforestry and natural resource management researchers are often under pressure from funding agencies and administrators to produce fast and easy results and technologies for immediate dissemination. Authors therefore tend to "please" the authorities by indulging in pedantic discussion and conclusions that do not emanate logically nor are substantiated by the results presented. For example, if the title suggests that the study is on insect populations in a mixed-plant system, the paper should focus on that, not on, say, reporting and discussing yield of crops and

elucidating how adopting such a practice can reduce deforestation. Some amount of speculative discussion, however, is in order to elicit excitement and motivate future research. The line between "optimum" and "excess" is often faint; the scientist has to do some balancing to separate rote from reasoning (Nair 2005).

Several hilarious stories are available to describe how the interpretation of observed results—the essence of Discussion—could be "interpreted." Two are worth mentioning here.

First, the classic joke of "Sherlock Holmes and the mystery of stars":

> Mr. Sherlock Holmes and his sidekick Dr. John H. Watson went on a camping trip. After a good meal and a bottle of wine they lay down for the night, and went to sleep. Some hours later, Holmes awoke and nudged his faithful friend.
>
> 'Watson, look up at the sky and tell me what you see.'
>
> Watson replied, 'I see millions and millions of stars.'
>
> 'What does that tell you?'
>
> Watson pondered for a minute. 'Astronomically, it tells me that there are millions of galaxies and potentially billions of planets. Astrologically, I observe that Saturn is in Leo. Theologically, I can see that God is all powerful and that we are small and insignificant. Meteorologically, I suspect that we will have a beautiful day tomorrow.'
>
> 'What does it tell you?' Watson asked.
>
> Holmes was silent for a moment, then spoke:
>
> 'Watson, you idiot, somebody has stolen our tent'.

The second story is about the elementary school science experiment to show the danger of alcohol:

> The teacher set up two glasses, one containing water and the other containing gin. A worm was dropped into each glass. The worm in gin died immediately while the worm in water swam around merrily. When the teacher asked the pupils what the experiment showed, little Johnny blurted out "If you drink gin, you won't have worms."

2.9 Conclusions

Conclusions should, rather than just repeating results, state well-articulated outcomes of the study and briefly suggest future lines of research in the area based on findings reported in the paper. In poor writing, it is not uncommon to find conclusions such as "more research is needed before conclusions can be drawn." In that case, why publish a paper from which conclusions cannot be drawn? Some journals do not allow a separate Conclusion section. In that case, the last paragraph or a few sentences of the Discussion can be used to state the conclusions.

2.10 Acknowledgments

This short section is for thanking the institutions and individuals who helped significantly in the work reported in the paper. This may be in a general way to a granting agency that supplied funds or a laboratory that supplied materials, or in a

specific way to a person or persons who gave you advice or helped you in data collection or analysis, or any other significant manner. This is also the place to mention the genesis of the paper, i.e., if it arose from a thesis or dissertation. If there is no separate acknowledgments section, such material and appreciation could be introduced at the end of the text, or in the Introduction or as a footnote or endnote.

2.11 References

Preparing a proper reference list is one of the most tedious aspects of finalizing a manuscript for publication. Part of the problem is that there is no standard or uniform format for citing literature, except that "All citations in the text, and only those, must be listed in the References." In other words, the References section and text citations should match perfectly. Although the saying that "there are as many reference-citation styles as there are journals" is an exaggeration, there seem to be as many reference-citation styles as there are publishers. Standardization of reference-citation style has been talked about for a while, and some progress has been made. The best rule to follow—as for many other aspects of scientific writing—is: follow the journal's instructions! Some software programs are available that aide in creating/formatting reference sections.

2.11.1 Common Styles of Literature Citation

References in biological and natural resource sciences are presented in one of the three common styles: name and year system, numbered alphabetical list, and citation-sequence system; the last one is used most frequently in medical sciences.

Name and Year system ("Harvard system"): The first author's last name and year of publication are given in parentheses in the text; the list is arranged in alphabetical order. In this system, it is easy to add or delete the references, which is an advantage to the author. To the reader, however, it is tedious when several citations are listed in the same sentence or paragraph, as in the Introduction and Discussion sections. It also adds to the word count: if "Scientist and Reader (2013)" can be replaced by "(6)" (a number), it saves space and printing cost.

Numbered Alphabetical listing: The list in the numbered alphabetical system is arranged in the same order, but the references are numbered. The citation in the text is by number in parentheses rather than name and year. The disadvantage—objection, rather—of the system is that many authors would like to see the author's name and year of publication right away while reading a text without having to sift through the reference list at the end. Some of this problem can be overcome by incorporating such details in the text for selected citations that are deemed more important than others: "The first textbook in agroforestry (12) …" can be stated more vividly as "Nair's 1993 book (12), the first textbook in agroforestry …"

Citation-Sequence system: Each citation in the text is given a number, usually as a superscript, in the order it is first mentioned in the text; the reference list is arranged sequentially by number and is not alphabetical. Obviously, addition or deletion of references is not easy and that could be a big problem for authors of papers with several references. The numbering in the order in which citations are listed will also separate out various references by the same author, which could also be a disadvantage.

Within these systems there are many variations, some minute, such as whether to enclose the parentheses, whether to put periods (full stops) after authors' initials, whether to write journal titles in full or abbreviate them, and so on. Interestingly, the *CBE Style Manual* (by the Council of Biology Editors) and the *Chicago Manual of Style*, two powerful and respected style manuals, have opposing views on style: the former adopts the number-alphabet system, while the latter endorses the alphabetical order of listings. In any case, the style being recommended by most science editors is to produce easily understood citations with a minimum of punctuation marks. Thus journal abbreviations are becoming almost uniform. Nowadays, "J" with or without a period after the letter is the accepted abbreviation for "Journal" (which used to be listed as "Journal" or "Jour."), and all "ology" words are abbreviated deleting the last "ogy" part ("Bacteriol" for "Bacteriology"; "Physiol" for "Physiology"; and so on). Note, however, that one-word titles of journals (*Science*, *Biochemistry*) are not abbreviated.

2.11.2 Some Other Issues of Reference Citation

- With the same name(s) and year, use 'a', 'b', after the year (example: Scientist 2009a, 2009b, etc.)
- Alphabetize 'Mc' following the order of the letters, not as if it were written out 'Mac': MacBrayne, Mackenzie, McDonald
- Alphabetize "St" in the same way, not as if it were written out "Saint" (or Street!): List "Stanley, St. Vincent, Sundar …" (not "St. Vincent, Stanley, Sundar …")
- While listing names with prefixes such as "de," "van," "von," and so on, use the form in which the name is listed by the author concerned, or follow the journal's directives
- Be specific and clear when referring to somebody's work or opinion (avoid the so-called "hand-waving reference"): do not refer to "Smith's classic work" without specifying what Smith's work was or how it is related to what is being reported
- When multiple authors are cited in a sentence, each for a specific work mentioned in the sentence, the relevant author should be listed against that specific work, rather than putting all citations together at the end of the sentence; for example "During the 1980s and 1990s, significant progress was made in identifying the numerous multipurpose trees used in indigenous

agroforestry systems and understanding the role of trees in soil productivity enhancement."[1,2,3,4] These citations become more appropriate and clear when the sentence is presented as "During the 1980s and 1990s, significant progress was made in identifying the numerous multipurpose trees used in indigenous agroforestry systems[1,2] and understanding the role of trees in soil productivity enhancement."[3,4]

2.12 Appendix

Any additional information that is relevant to the paper, but is of secondary importance, may be added as Appendix, subject to the journal's policy. These include details of ecological factors such as weather, soil, and plants; socioeconomic data; survey instruments such as questionnaires; procedures of any special laboratory analyses and statistical treatment of data; computer programs; and such other details that are useful for full explanation and understanding of the results, but are too bulky and complex to be included in the main text of the paper. Some journals encourage authors to present such data as "Supplementary Information" on the journal's webpage with due reference to the paper.

The IMRAD Format—Main Sections of a Scientific Paper

Section	Purpose
Title	What the paper is about
Authors	Names and affiliations of authors
Keywords	Words other than those in title that best describe the paper
Abstract	A stand-alone, short narrative of the paper
Introduction	***Why this paper?*** The problem, what is not known, the objective of the study
Materials and methods	***How was the study done***?
Results	***What did you find?***
Discussion	***What does it mean? What next?*** Interpretation of results and future directions
Conclusion	Possible implications
Acknowledgments	***Who helped and how; what was the funding source?***
References	Details of papers cited
Appendices	Supplementary materials

Chapter 3
Tables and Figures

Abstract Tables and figures are used to present quantitative data and clear illustrations of trends or comparisons. Although not essential in a paper, they are often an integral part of most scientific papers. Tables are for presenting exact numbers; figures show trends and features. Tables are used to summarize numerical values to facilitate their interpretation in the text. Figures emphasize the relationship among numbers; they include charts, diagrams, graphs, photographs and other illustrations. The same (sets of) data should not be presented in tables and figures; each table and figures should contain enough information for the reader to understand it clearly without referring to the text; and all tables and figures should be cited in the text.

3.1 Importance of Tables and Figures

Tables and figures are an integral part of a well-written scientific paper. Usually they appear in the Results section, but there are exceptions. Readers typically study the tables and figures before reading the text (in the ratio of about 10 to 1; i.e., for every ten persons who look at the tables and figures, one reads the full manuscript); thus, the tables and figures attract readers' attention the most after the Title and the Abstract.

Tables and figures are used to present data (quantitative data and illustrations for trends or comparisons) that cannot clearly be presented in text. By the same token, if the information can be presented clearly in the text, do not present it as tables or figures. Do not assume that a table or figure is always a must. Some beginners might think that a table or graph or chart somehow adds importance to the data and enhances the appeal of the paper. That is a wrong notion. Indeed, attempts to dress up scientific data are doomed to failure (Day 1988).

Journals do not allow too many tables and figures; the usual range is three to four each for a full research paper. Therefore, be judicious in the selection of materials to be presented as tables or figures. Climatic data during the study period is a "usual

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_3,

candidate" for a table or figure in papers reporting agricultural field experiments. Although such information may be important for understanding the results, it can often be mentioned in a sentence or two. In some situations, however, such as while reporting the results from multi-location experiments, it will be necessary to summarize in a table the site characteristics of the different locations (climate, soil type, and other relevant features). The point is that, unless there are convincing reasons, avoid using tables or figures for reporting the information that is not a part of, nor is essential for explaining, the results reported. Furthermore, do not present the same data in tables and graphs because that will mean repetition of the same information. Data presented in a table or figure should not be repeated in the text either, except that selected data may be picked and used in discussion.

3.2 Table Versus Figure

Tables are for presenting accurate numbers; figures show trends and features. Tables are used to summarize numerical values to facilitate their interpretation in the text of the paper. Figures emphasize the relationship among numbers; they include charts, diagrams, graphs, photographs and other illustrations. Choose the form that best serves the purpose of presenting the data: tables should be used to present specific numbers of actual data or estimates; figures should be used to focus on relationships among those numbers.

Some common guidelines on tables and figures are given below:

- All tables and figures are numbered sequentially in Arabic numerals (Table 1, Table 2, etc., and Fig. 1, Fig. 2, etc.) and are referred to in text by those numbers
- Reference to a table or figure should not be just to mention what they are about, but to emphasize the results presented; for example, avoid "Table 2 shows the soil organic matter content at different depths"; instead, say "soil organic matter content decreased with soil depth (Table 2)"
- The tables and figures should be placed in text as soon as possible after they are first referred to, but not before that
- In manuscripts submitted to journals that are type-set, tables and figures should be included, one per page, at the end of the text (after the References section).

A separate list of figures listing figure number, caption, footnotes, and any other information that needs to be type-set (i.e., is not a part of the drawing or illustration) should be included as well before placing the figures. In such cases, you may suggest the approximate position for each table and figure by marking the manuscript "Table X about here", "Fig. Y about here," etc.

3.3 Table Headings and Figure Captions

Each table and figure should stand on its own; i.e., the reader should be able to understand it fully without having to read the text. If the reader is asked to "see text for details," the chances are that he/she will rather leave that paper. In order to make

the tables and figures stand alone, each should have a complete heading or caption. Tables have headings and figures have captions; but sometimes these words are used synonymously. Usually, headings are printed on top of tables, and captions at the bottom of figures; however, some journals and other publications do not follow this pattern. Table headings and figure captions should give complete information for the reader to understand the contents of that table or figure, and be limited to one sentence; they should not contain units; units should be given at the appropriate positions (usually below column subheadings in tables and axes in figures). Remember that units are essential for understanding the data reported in the table or figure, but headings and captions report only the *nature* not the *details* of data. For example, if a table is reporting biomass yield, the heading need not specify if the values are g, kg, or Mg. Additional information or explanation that is essential for understanding the table or figure should be added at the bottom of the table; for figures, these should be added as subsequent phrases or sentences after the caption.

Long and multiple sentences are not acceptable as table headings either. All journals, however, do not follow this norm; indeed, some journals not only encourage, but even demand, a mini-discussion of the results, especially in figure captions. The cardinal rule is "Follow the journal's instructions to authors."

3.4 How to Construct Tables and Figures

Tables and figures should not report too much information. Remember that *all* results need not be reported; only important ones need to be. Manuscripts with too many long tables are really frightening! Imagine how a table (or figure) will look like if it reports data for all treatments and interactions of a factorial experiment with, say, 27 treatment combinations and five sampling dates in a field experiment, or 14 plant characteristics of all 95 trees that were examined in an indigenous-tree-improvement study! If all such data are important to your research and must be reported, the best way will be to report a summary in the paper, and post the details on a website and draw the readers' attention to that.

The information in the body of the table should be concise and clear. One way of doing this is by avoiding repetitive and trivial observations. A table should be organized to "fit the page," so that it can be read without rotating it; therefore the information provided, when printed, should fit in the portrait rather than landscape format. Abbreviations used should be explained (if needed) in footnotes. Vertical lines between columns should be avoided and horizontal lines kept to a minimum. The data should be arranged such that like elements read down not across: mental calculations are easier if numbers are placed vertically than horizontally. Some examples of poor tables are presented as Tables 3.1a and 3.2a, and their better forms as Tables 3.1b and 3.2b. Tables 3.1a and 3.1b contain exactly the same information and likewise between 3.2a and 3.2b; however, 3.1a looks larger than 3.1b, and 3.2a looks larger than 3.2b. Moreover, columns with numbers (Table 3.1b) look better in down (vertical) than in across (horizontal) arrangement.

Table 3.1 (a) Growth of two varieties of rice under three fertilizer treatments

Variable	Variety 1		
	Treatment 1	Treatment 2	Treatment 3
Plant height (cm)			
Biomass (g m^{-2})			
Leaf area index			
	Variety 2		
	Treatment 1	Treatment 2	Treatment 3
Plant height (cm)			
Biomass (g m^{-2})			
Leaf area index			

Table 3.1 (b) Growth of two varieties of rice under three fertilizer treatments

Variety	Treatment	Plant height (cm)	Biomass (g m^{-2})	Leaf area index
1	1			
	2			
	3			
2	1			
	2			
	3			

Table 3.2 (a) Some reported values of carbon (C) stock in agroforestry systems

Parameter	Agroforestry systems			
	Silvopasture	Home gardens	Shaded perennials	Parkland system
Study location				
Country	Florida, USA	Kerala, India	Bahia, Brazil	Ségoue, Mali
Rainfall (mm $year^{-1}$)	1,300	2,700	1,500	600
Soil order	Spodosols	Inceptisols	Oxisols	Alfisols
C Stock (Mg ha^{-1})				
Aboveground				
Soils (to 1 m depth)	190	110	300	30

Source Adapted from Nair et al. (2010)

Table 3.2 (b) Some reported values of carbon (C) stock in agroforestry systems

Agroforestry systems	Location			C Stock (Mg ha^{-1})	
	Country	Annual rainfall (mm)	Soil order	Above ground	Soils (to 1 m depth)
Homegardens	Kerala, India	2,700	Inceptisols		110
Parkland system	Ségou, Mali	600	Alfisols		30
Shaded perennials	Bahia, Brazil	1,500	Oxisols		300
Silvopasture	Florida, USA	1,300	Spodosols		190

Source Adapted from Nair et al. (2010)

Although it is desirable to organize the tables to fit the page (preferably in portrait format and not exceeding a page), some situations warrant a deviation from this norm. For example, while reporting results of inventory of plants in little-studied agroforestry systems, the list of plant species with their descriptions including Latin and local names may well exceed a page; similarly, review papers on certain topics may include reported values of the parameters under investigation from different locations and systems, leading to long tables spread out in multiple pages (e.g., reported values of carbon sequestration in agroforestry or other land use systems from different regions). One option in such cases, especially if journal space is limited, is to post the actual values on a website as supporting material, as mentioned before, and limit the paper to a synthesis of the extant datasets.

Figures should be clear and legible. Presenting a cluster of graphs each with its own standard error values makes the figure really clumsy. Similarly, flow charts and diagrams involving too many shapes (squares, rectangles, circles, etc.) and arrows of various types should be avoided. Another common problem is that with easy availability of color printers and software programs, the authors use color graphs even for journals that print usually in black and white. When color graphs are printed in black and white, they may appear as a fussy mass of indistinguishable lines. Graphs should maintain an overall balance. A histogram with too broad bands, and/or highly uneven heights is awkward. Select the appropriate graphical mode to present your data. For example, use histograms instead of a continuous graph obtained by joining data points to present discontinuous data such as the yield of a crop in different locations: it makes no sense to present them as a continuous graph.

3.5 Data Presentation Guidelines

- Statistical significance is expressed universally by * and ** to indicate significance at 0.05 and 0.01 levels of probability, respectively. Unfortunately, some use them in the reverse order: * for 0.01 and ** for 0.05. For absolute clarity, it is better to explain what you mean by these asterisks at the bottom of the table. In any case, asterisks (*) should not be used in tables and figures to express anything other than statistical information
- Notations such as a, b, c, etc. that are used to delineate differences based on multiple range tests (such as DMRT: Duncan's) also should be explained at the bottom of the table. In agroforestry literature, it is recommended that the place of study is included in each table heading and figure caption (as in the case of the main title of the paper)
- Use "n/a" (instead of dashes or zero) to indicate absence of a number
- Add a zero ("0") before the decimal point for numbers less than 1.0 (e.g., "0.25" instead of ".25")
- Data reported in tables and figures (as well as in text) should not contain more digits than the precision of the methods warrant. Usually, more than four digits including decimal points are not welcome. These four digits could be in any of

the following forms: 1.234, 12.34, 123.4 or 1,234. But there is no point in reporting a four-digit number followed by two decimal points. For example, the grain yield of a crop may be reported as 5,234, not 5,234.36, kg ha^{-1}

- In the SI system, the unit can easily be changed to avoid listing too many numerals: 50,000 g can better be expressed as 50 kg; write 2.4 million instead of 2,400,000
- In tables, round off the treatment means to one-tenth of their estimated standard error (SE) values. For example, if the estimated SE is 1.27, means should be rounded off to the nearest 0.1; if SE is 12.5, the means should be rounded off to the nearest 1.0.

Photographs may be used only to present information that cannot be presented quantitatively in graphs or other forms of visual presentations. When allowed, photographs are also numbered as figures (unlike in some old publications that used to label them as "Plates").

Tables and Figures in a Scientific Paper

- Tables and figures attract the most attention after Title and Abstract
- Use tables and figures only if they are essential
- Tables are for presenting accurate numbers, figures for trends
- Do ***not*** present same data in tables and figures
- Do ***not*** use tables and figures to report too much or too little data
- Avoid table/figure for presenting "routine" background information
- Each table/figure should "stand alone"; i.e., the reader should be able to understand the contents without reading the text
- Tables have headings; figures have captions
- Place headings on top of tables; captions at bottom of figures
- Headings and captions should be explicit but not verbose
- Present units separately, not as part of headings and captions
- Do not use more than four digits to report the data in tables and text; adjust decimal points and units accordingly (e.g., 50,000 g = 50 kg)
- Round off treatment means to one-tenth of SE (standard error) values [If SE is 1.27, round off the means to nearest 0.1]
- Abbreviations used should be explained (if needed) in footnotes
- Use "n/a" (instead of dashes or zero) to indicate absence of a number
- Add a zero ("0") before the decimal point for numbers less than 1.0 (e.g., "0.25" instead of ".25")
- Arrange the data so that like elements read down not across: mental calculations are easier if numbers are placed vertically than horizontally.

Chapter 4
The "Nuts and Bolts": Numbers, Units, Dates, Abbreviations, Nomenclature …

Abstract Writing a good scientific paper involves skillful assembly of the various components of the paper. For accomplishing that, well established guidelines and procedures need to be followed in the use of numbers, units, abbreviations, and such other features. The common norms and rules for the use of these "nuts and bolts" are described in this chapter. Although the exact requirements vary from journal to journal, the overall approach is similar, and all journals require that the authors pay meticulous attention to these standards. Failure to adhere to the norms will lead to rejection of the paper or delay in its publication.

4.1 Numbers

A number is more easily comprehended than words: 15,340 instead of fifteen-thousand-three-hundred-and-forty.

Two styles are followed in writing numbers in scientific papers.

- Spell out single-digit whole numbers (one to nine) in text except when followed by a unit of measurement (e.g., more than five), and in numerals for numbers 10 and above (e.g., more than 15). This applies also when using "-fold" to describe a magnitude of response; e.g., fivefold (one word), not 5-fold; but 15-fold (not "fifteenfold"); however, "-fold" should be used only for indicating increase, not decrease. In a mixed series containing some numbers more than 10 and others less, the recommendation is to use numerals throughout: 5 bananas, 8 apples, and 25 oranges
- The other style (recommended by some such as the *CBE Style Manual*) is to use numerals when the number designates anything that can be counted or measured; e.g., 2 farmers, 5 cows, 8 goats, and 12 trees.

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_4,

In both styles, use a word at the beginning of a sentence, not a numeral: do not start a sentence with "20 % of trees"; say "Twenty percent of trees". Furthermore, in both styles, use numerals when units of measures are included: 2 g (not two g), 5 m (not five m), and so on.

Fractions of numbers such as one-third ($^1/_3$), one-half ($^1/_2$), two-thirds ($^2/_3$), and so on should be expressed in words if they appear at the beginning of a sentence. Fractions in numerals ($^1/_3$, $^1/_2$, $^2/_3$) may be used if they "fit" well in the context in text. When expressed with decimal points (0.33, 0.50, 0.67), these fractions are just like any other number with a decimal point in tables, and have to be accompanied by relevant units if used in text.

Large Numbers: Numbers with five or more digits should be written with a space or a comma before the last three digits: e.g., 34 598 or 34,598; 231 574 or 231,574; and so on (in some journals, only spaces, not commas, are allowed in such cases). The English (US and British) practice is to mark a decimal point with a period (full stop) and groups of three digits with a comma. The European practice uses a comma for the decimal and a period (full stop) for groups of three digits. Thus, 12.500 will mean twelve thousand and five hundred in Europe. The SI (*Le Système International d'Unités*) recommends using a point (.) for the decimal (12.5 = twelve point five) and a space separating every three digits from the decimal (34 000 = thirty-four thousand). In text, four-digit numbers (1000 to 9999) should be written without any space, comma, or period: 1267, 3492, etc. In a table or column with a mixture of values, four-digit numbers should also be written with a space before the last three digits. Furthermore, while writing large numbers, a word can replace several zeros (25 million instead of 25 000 000). Similarly, units should be adjusted for numbers less than one to avoid a string of zeros after the decimal point (25 mg instead of 0.025 g or 0.000 025 kg). In tables and figures, modify the units instead of using expressions such as "$\times 10^3$" and "thousands" that were common in the past.

Range of Numbers: In scientific literature, inclusive numbers are written in full to avoid any chance of ambiguity; thus, 1997–1998 (instead of 1997–98, which, by the way, is the common way of writing it!), 227–249 (instead of 227–49). Some journals want the authors to shorten the inclusive numbers: 224–8 instead of 224–228. In some situations, it may need to be made clear that the last number is included in the range: e.g., 20 through 44 (US English) or 20 to 44 inclusive (UK English). Use a hyphen after the unit when it is an adjective: e.g., 20-day period.

A dash between two numbers usually indicates a range (i.e., 12–16 means 12 to 16). In common writing, however, we mostly use a hyphen instead of a dash (e.g., 12-16 instead of 12–16); but that is not correct. If a punctuation mark has to be used instead of "to" to indicate a range, it should be a dash, not a hyphen. Although the dash is not a keyboard character, it can easily be inserted in word-processing by typing the hyphen two times and hitting the space bar. A dash, however, is used to indicate the range in tables and bibliographic citations; e.g., "pages 12–16" is the right way of indicating page numbers in references. In text, the range may be written as 12 to 16; 12–16 may be acceptable too, but not preferred.

It is a common conversational style to say two-to-three hundred (meaning: 200 to 300), five-to-six million (5 million to 6 million), etc. In writing, however, avoiding the unit for the lower value of the range could lead to confusion: if the intent is to mean 200 to 300, write so; "two-to-three hundred" could mean 2 to 300. If two numbers appear together in text, the first should be spelled out: e.g., twelve 4-year-old trees rather than 12 4-year-old trees.

Negative Exponential versus Slash: In scientific writing, negative exponential should be used instead of slashes especially if there are more than one "per" in an expression: if it is a/b, it is clear that "a" is the numerator and "b" the denominator; but if it is a/b/c, it is ambiguous if "c" is a numerator or a denominator. This confusion can be avoided by writing all denominator values with the negative exponential sign: write 12 kg ha^{-1} yr^{-1} instead of 12 kg/ha/yr.

The expression "kg/ha/yr" is a common in popular writing in agriculture and natural resources such as extension literature, where kg ha^{-1} yr^{-1} may not even be understood properly by some of the targeted readers. In scientific literature, the correct expression is kg ha^{-1} yr^{-1}.

4.2 Units

- Weights and measures in science are reported using the SI units
- See Table 4.1 for the prefixes used with SI units
- The basic quantities used in most biological writing are three: units of length (meter or metre, m), mass (kg), and time (second, s). Other base units are electric current (ampere, A), thermodynamic temperature, kelvin, K), molarity (mole, mol), luminous intensity (candela, cd), and plane angle (radian, rd). See the tables for SI prefixes and conversion of non-SI units to SI units
- There is no uniform policy among journals about having a space between a number and a unit that follows it; e.g., 25 kg (a space between the two) versus 25kg (no space). Most journals seem to leave a space: 41.1 kg ha^{-1}, 52.4 mm, 10 d, and 20 g; similarly 2 mol L^{-1} KCl. Also, a space is given between number and molar (M), but M is in italics (0.05 *M* KCl). No space between the "less than (<)" and "more than (>)" symbols; however, while writing probability level (P) with the "<" and ">" symbols, a space is given after those symbols ($P < 0.05$ level)
- In the scientific literature of agriculture and natural resources, some non-SI units are extensively used; e.g., "y" or "yr" (for year; correct SI unit: "a" for annum), and t (for ton; correct SI unit: Mg for megagram)
- If a traditional unit that is well known in a country has to be used, give its equivalent SI unit (e.g., quintal that is popular in the Indian subcontinent to refer to 100 kg is not an SI unit). See Appendix 4.1 for conversions between SI and common non-SI units.

Table 4.1 SI unit prefixes

Term	Multiple	Prefix	Symbol
10^{24}	1 000 000 000 000 000 000 000 000	Yotta	Y
10^{21}	1 000 000 000 000 000 000 000	Zetta	Z
10^{18}	1 000 000 000 000 000 000	Exa	E
10^{15}	1 000 000 000 000 000	Peta	P
10^{12}	1 000 000 000 000	Tera	T
10^{9}	1 000 000 000	Giga	G
10^{6}	1 000 000	Mega	M
10^{3}	1 000	Kilo	k
10^{2}	100	Hecto	h
10^{1}	10	*Deca	da
	1 unit	–	–
10^{-1}	0.1	Deci	d
10^{-2}	0.01	Centi	c
10^{-3}	0.001	Milli	m
10^{-6}	0.000 001	Micro	μ
10^{-9}	0.000 000 001	Nano	n
10^{-12}	0.000 000 000 001	Pico	p
10^{-15}	0.000 000 000 000 001	Femto	f
10^{-18}	0.000 000 000 000 000 001	Atto	a
10^{-21}	0.000 000 000 000 000 000 001	Zepto	z
10^{-24}	0.000 000 000 000 000 000 000 001	Yocto	y

*In the United States, the spelling 'deka' is often used

4.3 Date and Time

- The most widely accepted pattern today in scientific literature is to write the date in the "day, month, year" order with no commas separating them, day and year in Arabic numerals. The month is usually abbreviated to first three letters; a period (.) may or may not be added after the abbreviated three letters of month; sometimes the months May, June, and July are not abbreviated. Unfortunately there is no uniformity among journals in this regard. However, if it is written in the "month, day, year" pattern, a comma is needed after the month: August 4, 2012. In either case, it is not desirable to write 4th August 2012 or August 4th, 2012
- In electronic data entry forms, usually the "DD/MM/YYYY" notations will specify day, month, and year
- Dates written fully in numerals can be confusing: for example, 8/4/2012 means August 4, 2012 (in the US) and 8 April 2012 (in the UK, India, and many other countries). In some countries, the year is written first, followed by month and day. Spelling out the month (in full or abbreviated to the first three letters) will avoid this confusion
- A decade or such other group of years can be indicated by adding an "s" without an apostrophe (e.g., 1990s)

- Time should be expressed using the 24-hour clock and four numerals rather than the use of a.m. or p.m.; thus, 08:30, 14:30 rather than 8:30 a.m., 2:30 p.m. A colon (:) is added between the hours and minutes (as well as hours, minutes, and seconds): 08:30, 14:30, 09:22:45, etc. In some countries, a period (.) is used instead of the colon as the separator between hours and minutes, but that should be discouraged, because 10.50 hours could mean ten-and-one-half hours or ten-hours-and-fifty minutes; the unambiguous way of writing ten-hours-and-fifty minutes is 10:50 h.

4.4 Abbreviations and Acronyms

It is a common practice in writing to substitute certain frequently used words with their short forms, which may be the first letter/s of the English word/s or of corresponding Latin words. Thus, "i.e." is the abbreviation of the Latin words *id est* meaning "that is"; "esp." is the abbreviation for "especially." Such commonly used abbreviations are listed in Table 4.2. Moreover, there are abbreviations that are specific to various technical fields; examples: "cv." for cultivar; "var." for variety; "syn." for synonym; and so on.

Abbreviations of a different kind are used to refer to institutions and events. In such cases, an abbreviation is a combination of the first letters of the words of a name. Sometimes a word is made up of parts or initial letters of the words of a name, and that is an acronym. If the abbreviation forms into definite syllable, it is used either as an abbreviation or an acronym depending on the user's preference. For example, UNESCO (United Nations Educational, Scientific, and Cultural Organization), when mentioned as a word, is an acronym; if the individual letters are spelled out as U-N-E-S-C-O, it is an abbreviation.

Table 4.2 Common abbreviations used in writing

Bibliog.	Bibliography, bibliographer, bibliographic, bibliographical
©	Copyright
c., ca.	*Circa*, about (used with approximate dates: c. 1756)
cf.	*Confer*, compare
ch., chs.	Chapter(s)
diss.	Dissertation
ed., eds.	Edited by, editor(s), edition(s)
e.g.,	*Exempli gratia*, for example (see e.g.,/i.e.)
enl.	Enlarged (as in rev. and enl. Ed)
esp.	Especially
et al.	*Et alii*, and others
etc.,	*Et cetera*, and so forth
f., ff.	And the following page(s) or line(s)
fig.	Figure

(continued)

Table 4.2 (continued)

fwd.	Foreword, foreword by
i.e.	*Id est*, that is
l., ll.	Line, lines
MS, MSS	Manuscript, manuscripts
NB	*Nota Bene*, take notice, mark well (always capitalized)
n.d.	No date (of publication)
n.p.	No place (of publication); no publisher
n. pag.	No pagination
p., pp.	Page, pages
pref.	Preface, preface by
proc.	Proceedings
pseud.	Pseudonym
pub (publ.)	Published by, publisher, publication
rept.	Reported by, report
rev.	Revised by, revision; review, reviewed by
sic	Latin for "so" or "thus": when used within brackets it means "it appeared thus"
soc.	Society
supp.	Supplement
trans.	Translated by, translator, translation
viz.	*Videlicet*, namely
vol., vols.	Volume, volumes
vs., v.	Versus, against (v. preferred in titles of legal cases)

Acronyms and abbreviations can be used in the text, but they should be defined the first time they are used. Generally, acronyms or abbreviations should be spelled out in words if used at the beginning of a sentence. But this rule is not applied to well-known entities; for example: FAO (the Food and Agriculture Organization of the United Nations) and IPCC (the Intergovernmental Panel on Climate Change) are so well known in related literature that many journals allow those abbreviations to appear at the beginning of sentences; others, however, require the full expansion of the abbreviation at its first mention. Follow the journal's Instructions to Authors and the editors' directives.

4.5 Nomenclature and Scientific Names

Nomenclature is a "system of names for things," "terminology of a science," or a "systematic naming." Different fields of science have different systems of nomenclature. In biology, for example, we use the binomial nomenclature (in Latin) for living organisms. Similarly there are nomenclatures in chemistry and biochemistry, and physics and mathematics. Each system of nomenclature has strict rules that are well recognized, understood, and adhered to by a wide circle of scientists. The Instructions to Authors of a journal will have guidelines on nomenclature needs for papers submitted to that journal.

The complete scientific names (the full binomial name in Latin) should be given for all plants (even if they are very popular names such as rice and wheat) and other organisms in the abstract and text of the paper. Latin names should be in italics (which is easy to do in word processing) or be underlined. The genus name always begins with a capital letter, and the species name with a lower-case letter. If a common name is used, the scientific name should be given along with the common name when the plant (or organism) is mentioned for the first time. There is a tendency to use the genus name as the common name for a plant (or organism) for which either a universally acceptable common name is not available, or the plant (or organism) is known better by such "artificial" common name (genus name) than by any of the obscure or obsolete English names that might exist. A good example is the tree *Leucaena leucocephala* (Lam.) de Wit, which is very popular in agroforestry. Some dictionaries list "horse tamarind" and "lead tree" as its English names. The tree is popularly known as "Ipil-Ipil" in the Philippines and "Subabul" in many parts of India. In agroforestry literature, it is known as leucaena. When used as a common name, it should be written the first time in the text as "*Leucaena leucocephala* (Lam.) de Wit (hereafter referred to as leucaena)" and as leucaena thereafter in the paper, but not *leucaena* (in italics with a lower-case "*l*") or Leucaena (with a capital L and not in italics, except at the beginning of a sentence where it should be a capital L). A genus name can be used alone, but a species name must always be preceded by the name or the first letter of the genus name. If the species name is unknown, or if the reference is to several species in a genus, use "sp." (for singular) or "spp." (for plural); thus, *Musa* sp., and *Coffea* spp. Sometimes, "spp." is written as "spp" (without a period—full stop—except when it appears at the end of a sentence. Remember that the words or abbreviations and authority names that are not a part of the Latin scientific name itself are not written in italics; thus sp., spp., cv. (cultivar), and var. (variety) should not be italicized: e.g., *Alnus acuminata* Kunth subsp. *acuminata*; *Cocos nucifera* L. var. Tall; *Triticum* spp.; *Zea mays L.*

One of the difficulties in writing complete scientific names is in giving correct author names. To be complete and correct, all plant names in Latin should be followed by the abbreviated name of the authority who first gave the taxonomic description of that organism. The difficulty arises when several authority names are attached to a plant name (indicating a lack of authority on authority names!). While long-domesticated plants such *Oryza sativa* L. or *Zea mays* L. do not pose any problem, plants whose taxonomy is still unclear—and there are several such species in agroforestry—could create a problem if all authority names that are attached to that organism are to be mentioned, especially in a title or an abstract; examples: *Cordia alliodora* (Ruiz et Pav.) Cham.; *Grevillea robusta* A. Cunn. ex R. Br. Obviously, attaching such a string of authority names to the title or abstract is clumsy and affects its readability. In animal sciences, when a taxonomist changes the placement of the organism to a different genus, the name of the original authority is then placed in parentheses. For example, the name *Lepomis gulosus* (Cuvier) indicates that Cuvier originally described the animal but placed it

in a different genus, that it was later moved into the genus *Lepomis*, and who made that move is uncertain. In plant sciences, the names of both the original describer and the one who later made the taxonomic move are given.

4.6 Mathematical and Statistical Expressions

- Mathematical equations and formulas (formulae) and special symbols such as Greek letters should be written clearly and as simply as possible (which can be done by word-processing software) so that the typesetter and the editor have a clear understanding
- Use brackets in the order: parentheses ( ) first, then square brackets outside those [ ], and then braces { } outside those:

  Example: $\{[x\ (a + b)]\ [y\ (c + d)]\}^3$

- Identify each mathematical expression by a separate number in sequence (1, 2, 3, etc.), and use that number to refer to the expression elsewhere in the text; the number may be aligned to the right and enclosed in (parentheses), [square brackets], or {braces} according to the journal's instructions
- Simple mathematical expressions can be written as part of normal sentences, but with proper grammar and punctuation, and without the "identification number" referred to above; in mathematical sentences, signs should be replaced by proper words: e.g., use "=" only in mathematical expressions; in a mathematical sentence, replace it with "is" or "equals"
- A space should not be added after a mathematical function word such as log; e.g., log(x). While writing a negative number, avoid a space between the negative sign and the number: e.g., −25 (not − 25).

By convention, "significant," "highly significant," and sometimes "very highly significant" are the statistical expressions of difference between treatments, based on probability of $P < 0.05$, $P < 0.01$, and $P < 0.001$ (and indicated by *, **, and ***, respectively, in tables). Some journals discourage the use of these words indicating levels of significance, and ask instead the actual p-value associated with the effect be given. A common problem in this context is the tendency to say "significantly different" and then give the probability level. Some argue that it is not correct to say that the treatments are different unless the difference is statistically significant. Some authors try to "stretch" the borderline results by implying that the treatments are different even if not significantly different by adding imprecise statements such as "almost significant, but failed to attain the level of significance," attributing that to limited number observations and other "excuses." Obviously, these undesirable tactics should be discouraged. The best way would

be to report the actual P value (instead of saying if it was slightly above 0.05); any discussion as to why the P value did not reach the 0.05 level could be included in the Discussion section. In tables, it is customary to report the treatment mean followed by ± standard error (SE) of the mean, or report the SE in parentheses after the mean even for differences that are declared statistically not significant.

In conclusion, it is very important to pay proper attention to the correct use of the various "nuts and bolts" discussed above. Although the exact requirements vary from journal to journal, the overall approach is similar, and all journals demand that the authors pay meticulous attention to these standards. Failure to adhere to the norms will lead to rejection of the paper or delay in its publication.

Appendix 4.1: SI Units and Conversion Factors

The authoritative source of the international system of units is the publication in French language, *Le Système International d'Unités (SI)* by the International Bureau of Weights and Measures (BIPM). The fifth edition of the book was published in 1985; its United States edition in English translation (Goldman and Bell 1986) is the main source of the information given here. Other relevant sources are also listed at the end of the section.

SI Base Units

The SI base units of the factors used in this book are:

	SI unit	
Quantity	Name*	Symbol
Length	Meter (metre)	m
Mass	Kilogram (kilogramme**)	kg
Time	Second	s
Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

*Expressions in British English in parentheses
**Seldom used in current literature

Examples of SI derived units expressed in terms of base units

	SI unit	
Quantity	Name	Symbol
Area	Square meter	m^2
Volume	Cubic meter	m^3
Speed, velocity	Meter per second	$m\ s^{-1}$
Acceleration	Meter per second squared	$m\ s^{-2}$

(continued)

(continued)

	SI unit	
Quantity	Name	Symbol
Density, mass density	Kilogram per cubic meter	kg m^{-3}
Specific volume	Cubic meter per kilogram	m^3 kg^{-1}
Luminance	Candela per square meter	cd m^{-2}

Units in use temporarily with the International System

Name	Symbol	Value in SI units
Angström	Å	1 Å = 0.1 nm = 10^{-10} m
Hectare	ha	1 ha = 10^4 m^2
Bar	bar	1 bar = 0.1 MPa = 100 kPa = 10^5 Pa

Pa = pascal

Non-SI units in use with the International System

Name	Symbol	Value in SI units
Minute	min	1 min = 60 s
Hour	h	1 h = 60 min = 3 600 s
Day	d	1 d = 24 h = 86 400 s
Degree	°	1° = (π/180) rad
Minute	′	1′ = (1/60)° = (π/10 800) rad
Second	″	1″ = (1/60)′ = (π/648 000) rad
Liter	L (l in UK English)	1 L = 1 d m^3 = 10^{-3} m^3

Note In agricultural literature, yr, or a (for annum), is commonly used to refer to year

Rules for Writing and Using SI Unit Symbols

1. Roman (upright) type, in general lower case, is used for the unit symbols. If, however, the name of the unit is derived from a proper name, the first letter of the symbol is upper case (e.g., Kelvin = K; Newton = N).
2. Unit symbols are unaltered in the plural (e.g., kg for kilogram as well as kilograms).
3. Unit symbols are not followed by a period or full stop (.); for example: kg is right, kg. is not

   (a) The product of two or more units is indicated as follows, for example:

   N. m or usually leaving a space in between instead of a period (or full stop), as N m.

   (b) A solidus (oblique stroke, /), a horizontal line, or negative exponents, may be used to express a derived unit formed from two others by division, for example:

$$m/s, \frac{m}{s}, m\,s^{-1}.$$

(c) The solidus must not be repeated on the same line unless ambiguity is avoided by parentheses. In such cases, it is preferable to use negative exponents without periods (full stops) in between; for example:

$$\mathrm{m/s^2 \text{ or } m\,s^{-2}}$$
$$\mathrm{kg/ha \text{ or } kg\ ha^{-1}, \text{ but not } kg/ha/yr.}$$

Basic conversion factors

Quantity	SI unit	Metric system (≈SI)	English system
Length	1 m	100 cm = 10^{-3} km	39.37 inches = 3.281 feet 1 inch = 2.54 cm
Area	1 m^2	10^4 cm^2 = 10^{-4} hectare	10.76 ft^2 = 1,550 in^2 1 ft^2 = 0.929 m^2
		1 hectare	2.47 acres 1 acre = 0.4047 ha
Volume	1 m^3	10^6 cm^3 = 10^3 L	264.2 gallons (US)
		1 L	0.264 gal (US) 0.212 gal (British) 1 gal (US) = 3.786 L 1 gal (British) = 4.55 L 1 fluid ounce (US) = 29.6 mL 1 oz = 1/16 lb = 28.35 g
Mass	1 kg	1,000 g t = 1 metric ton or tonne = 1,000 kg	2.20462 pound (lb) 1 lb = 0.454 kg 2,204 lbs 1 ton (US) = 2,000 lb = 907.2 kg

Conversion factors for SI and non-SI units

To convert column 1 into column 2, multiply by	Column 1 SI unit	Column 2 non-SI unit	To convert column 2 into column 1 multiply by
Length			
0.621	Kilometer, km (10^3 m)	Mile, mi	1.609
1.094	Meter, m	Yard, yd	0.914
3.28	Meter, m	Foot, ft	0.304
1.0	Micrometer, μm (10^{-6} m)	Micron, μ	1.0
3.94×10^{-2}	Millimeter, mm (10^{-3} m)	Inch, in	25.4
10	Nanometer, nm (10^{-9} m)	Angström, Å	0.1
Area			
2.47	Hectare, ha	Acre	0.405

(continued)

(continued)

To convert column 1 into column 2, multiply by	Column 1 SI unit	Column 2 non-SI unit	To convert column 2 into column 1 multiply by
247	Square kilometer, km^2 (10^3 m)^2	Acre	4.05×10^{-3}
0.386	Square kilometer, km^2 (10^3 m)^2	Square mile, mi^2	2.590
2.47×10^{-4}	Square meter, m^2	Acre	4.05×10^3
10.76	Square meter, m^2	Square foot, ft^2	9.29×10^{-2}
Volume			
9.73×10^{-3}	Cubic meter, m^3	Acre-inch	102.8
35.3	Cubic meter, m^3	Cubic foot, ft^3	2.83×10^{-2}
6.10×10^4	Cubic meter, m^3	Cubic foot, ft^3	1.64×10^{-5}
3.53×10^{-2}	Liter, L (10^{-3} m^3)	Cubic foot, ft^3	28.3
0.265	Liter, L (10^{-3} m^3)	Gallon (U.S.)	3.78
33.78	Liter, L (10^{-3} m^3)	Ounce (fluid), oz	2.96×10^{-2}
Mass			
2.20×10^{-3}	Gram, g (10^{-3} kg)	Pound, lb	454
3.52×10^{-2}	Gram, g (10^{-3} kg)	Ounce (avdp), oz	28.4
2.205	Kilogram, kg	Pound, lb	0.454
10^{-2}	Kilogram, kg	Quintal (metric), q	10^2
1.10×10^{-3}	Kilogram, kg	Ton (2,000 lb), ton	907
1.102	Megagram, Mg (tonne)	Ton (US), ton	0.907
1.102	Tonne, t	Ton (US), ton	0.907
Yield and rate			
0.893	Kilogram per hectare, kg ha^{-1}	Pound per acre, lb $acre^{-1}$	1.12
0.107	Liter per hectare, L ha^{-1}	Gallon (US) per acre	9.35
893	Tonnes per hectare, t ha^{-1}	Pound per acre, lb $acre^{-1}$	1.12×10^{-3}
893	Megagram per hectare, Mg ha^{-1}	Pound per acre, lb $acre^{-1}$	1.12×10^{-3}
0.446	Megagram per hectare, Mg ha^{-1}	Ton (2,000 lb) per acre, ton $acre^{-1}$	2.24
2.24	Meter per second, m s^{-1}	Mile per hour	0.447
Temperature			
1.00 (K −273)	Kelvin, K	Celsius, °C	1.00 (°C +273)
(9/5 °C) +32	Celsius, °C	Fahrenheit, °F	5/9 (°F −32)
Energy, work, quantity of heat			
0.239	Joule, J	Calorie, cal	4.19
1.43×10^{-3}	Watt per square meter, W m^{-2}	Calorie per square centimeter minute (irradiance), cal cm^{-2} min^{-1}	698

(continued)

(continued)

To convert column 1 into column 2, multiply by	Column 1 SI unit	Column 2 non-SI unit	To convert column 2 into column 1 multiply by
Transpiration and photosynthesis			
3.60×10^{-2}	Milligram per square meter second, mg m^{-2} s^{-1}	Gram per square decimeter hour, g dm^{-2} h^{-1}	27.8
10^{-4}	Milligram per square meter second, mg m^{-2} s^{-1}	Milligram per square centimeter second, mg cm^{-2} s^{-1}	10^4
Electrical conductivity			
10	Siemen per meter S m^{-1}	Millimho per centimeter, mmho cm^{-1}	0.1
Water measurement			
9.73×10^{-3}	Cubic meter, m^3	Acre-inches, acre-in	102.8
9.81×10^{-3}	Cubic meter per hour, m^3 h^{-1}	Cubic feet per second, ft^3 s^{-1}	101.9
4.40	Cubic meter per hour, m^3 h^{-1}	U.S. gallons per minute, gal min^{-1}	0.227
Concentrations			
1	Centimole per kilogram, cmol kg^{-1} (ion exchange capacity)	Milliequivalents per 100 grams, meq 100 g^{-1}	1
0.1	Gram per kilogram, g kg^{-1}	Percent, %	10
1	Milligram per kilogram, mg kg^{-1}	Parts per million, ppm	1
Plant nutrient conversion			
	Elemental	Oxide	
2.29	P	P_2O_5	0.437
1.20	K	K_2O	0.830
1.39	Ca	CaO	0.715
1.66	Mg	MgO	0.602

Sources
Goldman and Bell (1986), Nair (1993), Soil Science Society of America (2001)

Part II
English—The International Language of Science

Chapter 5
Words

Abstract Choice of appropriate words enhances the presentation quality of a research paper. Common issues of use and misuse of words include: gender bias, modifiers, idioms, jargon, verb-based noun, collectives, spelling (US vs. UK forms), specialized words, and similar words with different meanings. Examples of each category are provided to illustrate the nature of issues.

Writing is all about words. Successful writing involves using words that are accurate, appropriate, and familiar. The words you choose should mean what you want to say, fit well with other words in the paper, and be easy to read and understand. It is, however, not an easy task to choose the right words always! Let us consider some of the common issues related to use (and misuse) of words.

5.1 Gender and Pronouns

The English language provides for recognition of three genders: masculine, feminine, and neuter that can be identified by the choice of the appropriate pronoun (*he, she, it*). Only these pronouns and a select few nouns (*host*/*hostess*) reflect gender. Writers must be sure that nouns and pronouns within a grammatical construction agree in gender. A pronoun, for example, must agree with its noun antecedent in gender. Thus, a woman is referred to as *she* or *her*, not as *it*; a man as *he* or *him*, not as *it*; and a barn as *it*, not as *he* or *she*.

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_5,

5.1.1 Gender Bias

Authors should be careful to avoid any gender bias in the paper.

- An antecedent that includes both sexes, such as *everyone* and *student*, is sometimes considered as a masculine pronoun. To avoid implying gender bias, it is better to use plural nouns and pronouns in such situations. For example:

  Change: "Every *scientist* should be aware of *his* responsibilities"
  To: "*All* scientists should be aware of *their* responsibilities"

  Change: "Each farmer received *his* share"
  To: "*All* farmers received *their* share"

- Using "he/she" or "his/her" avoids the gender bias, but that sort of construction is awkward. Using "they" instead of "he/she" in such situations is now becoming common: "Everybody should be aware of *their* responsibilities." Arguably, it is grammatically not correct to use a plural pronoun to denote a singular subject; but use of "they" as a singular pronoun is an old practice: *If a person is born of a gloomy temper… they cannot help it* (Lord Chesterfield 2002)
- To say "the farmer and his wife" is not only biased, but is likely inaccurate, too, especially in Africa where a high percentage of farmers are women
- Words with discriminatory overtones such as "spokesman" and "mankind" may be replaced by gender-neutral alternatives; e.g., "handmade" instead of "man-made"; "personnel," "human resources," or "staff" instead of "manpower"
- Gratuitous, gender-specific modifiers such as "women scientists" and "women farmers," should be avoided
- Many words in English are traditionally given a sex. Cars and ships are frequently called "she." Use "it" instead; "sister institute" may be changed to "related institute".

5.1.2 Personal Pronouns

- Personal pronouns are used sometimes to make a more lively style and easier reading than in the classical, impersonal language. 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…"
- "One," or the passive voice, sometimes serves as a third-person pronoun; but make sure that it is not used in an awkward manner

  Change: "Contour planting can help one to reduce soil erosion from one's land"
  To: "Contour planting can help reduce soil erosion".

5.2 Modifiers

Modifiers are words, phrases, or clauses that expand, limit, or help clarify the meaning of other elements in a sentence by functioning mostly as adjectives or adverbs. As a general rule, the best way to avoid ambiguity is to place the modifiers close to the word being modified.

Jammed Modifiers: These are strings of modifiers preceding nouns making the writing unclear and difficult to read. They often result from an overuse of jargon or elimination of prepositions or connectives. Example: The readability of the clumsy sentence *Soil carbon storage capacity measurement procedure* needs improvement can be enhanced by breaking up the jammed modifiers to The *procedure for measuring the capacity of soils to store carbon* needs improvement. Some authors use the "trick" of jammed modifiers to reduce the number of words in the title to stay within the journal's strict limits.

Noun Clusters: These are another form of jammed modifiers formed by using nouns as adjectives and putting strings of them to form a phrase.

Example: "*Research results dissemination improvement methods"* can be stated much more clearly as *"Methods of improving the dissemination of research results."*
Unfortunately, noun clusters are becoming common today in science writing. They may sound impressive to some, but usually make the message unclear or ambiguous.

Misplaced Modifiers: A modifier (word, phrase, or clause) is misplaced when it modifies, or appears to modify, the wrong word or phrase.

- *Misplaced Words*: Possible confusion in sentences of this type can be avoided by placing the adverb immediately before the word it is intended to modify. See the following sentences:

  "We *almost* lost all the data" (all of the data were *almost* lost, but they were not) versus
  "We lost *almost* all the data" (a major part of the data (*almost all*) was in fact lost)

- *Misplaced Phrases*: Note how the meanings change when the phrase is shifted in the following sentences:

  "The plants *with fertilizer packages* sold the best." (Different types of plants were available for sale, some with and some without fertilizer packages.) versus
  "The plant sold the best *with fertilizer package*." (Only one type of plant was available, and the fertilizer package was optional)

- *Misplaced Clauses*:

  Example: "We sent the brochure to four local firms *that had three-color art*"
  "We sent the brochure *that had three-color art* to four local firms"

- *Other types of Misplaced Modifiers*: Certain modifiers cause confusion when they are out of place. For example, see how the meanings change in the following sentences:

  Only fish survives in water. (*Nothing else except fish survives in water*)
  Fish only survives in water. (Fish *does nothing but survive in water*)
  Fish survives only in water. (*Nowhere else but in water can fish survive*)
  Fish survives in water only. (*A more emphatic version of the previous sentence*)

Dangling Modifiers: These glaring errors leave the reader utterly confused

Example: "At age six, we thinned the tree stand." versus
"We thinned the stand when the trees were six years old."

Squinting Modifiers: A modifier "squints" when it can be interpreted as modifying either of two sentence elements simultaneously, so that the reader is confused about which is intended.

Example: "We agreed *on the next day* to plant the trees."

This sentence could mean either of the following:

"We agreed *to plant the trees on the next day*."
"On the next day we agreed to plant the trees."

Intensifiers: Some modifiers (adverbs) become intensifiers when they increase the impact of adjectives (*very* fine, *too* high) or adverbs (*rather* hastily, *very* slowly). Use of such intensifiers that lead to exaggeration and therefore inaccuracies is discouraged in scientific writing.

Word Order: The place a particular word is positioned in a sentence can influence the meaning of that sentence, sometimes profoundly. Example:
Add the word "only" at different positions in the sentence "He said he could do that research…"

Only he said he could do that research… (no one else agreed with him)
He *only* said he could do that research… (but, he did not demonstrate it)
He said *only* he could do that research… (he is the world leader)
He said he *only* could *do* that research…

(1) emphasis on "do": he could do the research but not any follow up
(2) emphasis on "he only": means he is the world leader

He said he could *only* do that research… (he refused to work on anything else)
He said he could do *only* that research… (he has extremely limited abilities)
He said he could do that research *only*… (limited abilities, again)

Similarly, substitute "also" for the word "only" and see how the meanings change.

5.3 Idioms

These are groups of words that have a special meaning apart from their literal meaning. Certain prepositions follow certain verbs, nouns, and adjectives to form the idiom. No definite pattern is available to explain such usages; the best advice is to check in a dictionary. The classical example of someone seeking public office being described as "running for office" (in the United States) and "standing for office" (in the UK) illustrates how the idioms of the two countries differ. Some common idioms that are relevant to the scope of this book are listed in Table 5.1.

Table 5.1 Some common idioms used in scientific writing

accordance with
according to
accountable for (actions); accountable to (a person)
adapt for (a purpose); adapt to (a situation); adapt from (change)
adhere to
adverse to
affinity between, with
agree on (terms); agree to (a plan); agree with (a person)
approve of
argue for, against (a policy); argue with (a person)
arrive in (a city, country); arrive at (a specific location, conclusion)
based on, upon
compare to (things that are similar but not the same kind)
compare with (things of the same kind to determine similarities and differences)
comply with
concur in (consensus); concur with (a person)
conform to
consist of
convenient for (a purpose); convenient to (a place)
correspond to, with (a thing); correspond with (a person)
deal with
depend on
deprive of
differ about, over (an issue); differ from (a thing); differ with (a person); differ on (amounts, terms)
different from

(continued)

Table 5.1 (continued)

disagree with (a person)
disapprove of
divide between, among
divide into (parts)
engage in
exclude from
expect from (things); expect of (people)
expert in
identical with, to
imply that
impose on
improve on
inconsistent with
independent of
infer from
inferior to
necessary for (an action); expect of (people)
necessary to (a state of being)
occupied by (things, people); occupied with (actions)
opposite of (qualities)
opposite to (positions)
proceed with (a project)
proceed to (begin)
rely on
responsibility for, of
reward for (an action)
reward with (a gift)
similar to
surrounded by (people)
surrounded with(things)
talk to (a group); talk with (a person)

5.4 Jargon

A jargon is "a mode of speech familiar only to a group or profession." Each discipline has its special "language" and technical words that may be understandable to members of that discipline, but not necessarily others. Authors have to be careful about the use of such jargons. Unlike what some (relatively inexperienced) authors seem to think, use of too many jargons does not enhance the "standard" or value of the paper.

A fine line exists between a jargon and a commonly accepted word: in course of time, a jargon may become a common word through repeated usage. For example, some of the commonly used words in electronic communication today were jargons when they first appeared some 20 years ago; e.g., online publication, Google search, DOI—digital object identifier, and so on. They used to be defined in the

literature of those days, but it will be redundant to define such words today. That is also how languages evolve and expand their vocabulary with time.

Several words used in agroforestry literature (e.g., alley cropping, improved fallow, silvopasture, and so on) do not need any explanation or definition in a paper in an agroforestry-focused journal now (unless, of course, a review of the definitions is the objective of the paper). Such terms will, however, need to be defined if the article is for a journal that does not usually publish agroforestry papers. Manuscript reviewers and journal editors will advise authors whether to define terms that are considered not understandable by the readers of the journal concerned.

5.5 Nouns from Verbs

Abstract nouns are often those made from verbs: e.g., "to measure" gives "measurement." But because it is a noun, a verb has to be added to it: "The measurement was done (or carried out)."

Other common examples: "production" (from "produce"); "interpretation" (from "interpret"), "observation" (from "observe"), and so on.

In science writing today, abstract nouns are common, but it is better to avoid using too many of them (but, what is *too many*?!). When reviewing the manuscript before final submission, look for the nouns ending in -tion, -ance, -sion, -ment, -ness, -cy. Usually these can be replaced by rewriting the sentence using the verb. Replacing an abstract noun with a verb gives more chance to bring the subject into the sentence and make it more alive and specific. These changes may also shorten a sentence and put its elements into a clearer sequence. For example:

> "The variation was measured" is much better than:
> "Measurements were carried out on the variation."

Similarly,

> "It is possible that the pattern of herbs now found at the site is a reflection of past disturbances." can be better stated as:
> "The pattern of the herbs now found at the site may reflect past disturbances."

5.6 Collectives

Committee, group, set, pair, couple, and series are all singular nouns; but each denotes more than one person or component. They will attain plural forms when used in conjunction with the words denoting those persons or components; e.g., "The couple was seated in the front row; a couple of people who came in next were seated in the row behind." But, "50 kg fertilizer *is* added" or "20 mL of the reagent *was* needed" (the reference is to a specific singular unit).

5.7 Spelling

English is a language of variant spellings; i.e., many words can be spelled "correctly" in more than one way. Many of these variations are due to the differences between the US and British forms of spelling. Some mixed forms are also used; e.g., Canadian English that has elements of both US and British styles. None of these forms can be argued as "the right" form. This can cause confusion especially for those whose first language of communication is not English. The best way to overcome this problem is to check journal's style and Instructions to Authors. In any one article, stick to a single chosen style throughout. Sometimes, in books or conference proceedings, the editors may allow individual contributors to use either US or British spelling for their chapters. Authors are strongly encouraged to use the marvels of electronic writing aids such as choice of US/UK/any other style, spell-check and grammar-check programs, and online dictionaries.

In spite of the availability of all the electronic aids and programs, basic skills in spelling, grammar, and other aspects of writing are essential for scientists to write their papers well. One such basic skill is the ability to understand the differences between the US and UK spelling styles; these are summarized in Table 5.2.

Regardless of the style choice, however, spellings in proper nouns should NOT be modified. For example, while referring to a paper written in US English, the "World Agroforestry **Centre**" should not be written as World "Agroforestry ***Center"*** because the Centre is a specific name in this case. Similarly, UNDP is the United Nations Development Programme (not … *Program*). A publication listed in the References should cite the title exactly as in the original source. For example, if a publication printed in UK English is cited in a paper written in US English, the References section should list the publication's title as it is in the original (UK English). This applies also to articles published in European languages other than English. For publications in other languages with abstracts in English, the English title provided in the abstract should be listed with the words (original in—language, with abstract in English).

Details of various other forms of stylistic differences that exist between the US and British forms of English are beyond the scope of this book. Some of them, however, are mentioned in the context of certain specific issues such as expressing a range of numbers (Sect. 4.1) and writing dates in all numerals (Sect. 4.3).

5.8 Specialized Words

Each professional subject has its own specialized words; many of these are common words that have acquired special meaning in that specific subject or discipline. For example, to a plant pathologist or entomologist, a vector is an insect or anything else that transmits a disease from one organism to another; an airplane pilot or air traffic controller uses that word to mean "to give direction" ("Please

Table 5.2 Common differences between the US and UK styles of English Spelling

Characteristic forms	*Example*	
	US English	UK English
OR vs. OUR ending	color	colour
	honor	honour
	humor	humour
IZE vs. ISE ending	organize	organise
	analyze	analyse
	recognize	recognise
ER vs. RE ending	center	centre
	fiber	fibre
	theater	theatre
ED vs. T ending	burned	burnt
	learned	learnt
	spoiled	spoilt
SINGLE vs. DOUBLE consonants before an "ed" or "ing" ending	canceled	cancelled
	benefited	benefitted
	focusing	focussed
	worshiping	worshipped
SILENT VOWEL (drop vs. retain)	anesthetic	anaesthetic
	encyclopedia	encyclopaedia
	maneuver	manoeuvre
E at the end of the root word (drop vs. retain before adding a suffix)	aging	ageing
	usable	useable
	acknowledgment	acknowledgement
Other expressions		
	among	among, amongst
	while	while, whilst
Chemical elements		
	Aluminum	Aluminium
	Sulfur	Sulphur
Units and numbers		
	Liter (L)	Litre (l)
	Milliliter (mL)	Millilitre (ml)
Billion	One thousand million = 10^9	One million million (10^{12}) (in old usage)

see Appendix 4.1 for other units and conversion factors

Source Some sections are adapted from Stilman (1997)

vector me to the nearest airport."); and to a mathematician or a computer scientist, a vector has entirely different meanings.

Singular and plural forms of commonly used words are sometimes used incorrectly. For example, data, phenomena, and criteria are all plural, not singular; equipment, furniture, information, and punctuation are always singular and they never take an "s" at the end to make them plural.

It is a relatively recent tendency in technical and professional writing in agriculture and natural resources to drop the hyphen from several compound adjective words that used to be written with a hyphen; examples: landuse systems (vs. land-use systems or land use systems); semiarid (vs. semi-arid or semi arid) climate, aboveground (vs. above-ground or above ground) biomass.

Not significant (vs. insignificant) is a common specialized usage in scientific writing. When the difference between two values is said to be "not significant," it refers to the lack of statistical significance between the two values at the specified level of probability, not that the values are "insignificant." A classical joke goes like this: "A professor who found many problems with English language usage in the thesis of a student whose first language is not English asked the student to get the thesis scrutinized for English; when it came back, a major change was that the words 'not significant' had been replaced by 'insignificant' throughout the document!"

5.9 Similar Words, Different Meanings

The English language has several homonyms, i.e., words that are spelled differently, but pronounced the same way. Then, there are words that are different but have similar meanings. Both these groups of words can be a major source of error to most writers. Some of the common ones, again relevant to the scope of this book, are presented here. Note that some of these are also included in Table 5.1.

- **affect/effect**

  affect is a verb that means influence. Plant growth is affected by climate.
  effect is usually used as a noun that means "result." The effect of nitrogen was not significant. *Effect* can also be used as a verb to mean "bring about" or "cause"; it is best, however, to avoid using it as a verb

- **all-around/all-round/all around**

  all-around and *all-round* both mean "comprehensive" or "versatile"
  e.g., The institute started an all-round training program in research writing
  All around is a two-word phrase: The fence was installed all around the building

- **all right/all-right/alright**

  all right means "all correct," as in "The answers were all right." It is always written as two words, with no hyphen; *all-right* and *alright* are incorrect

- **all together/altogether**

  all together means "all acting together," or "all in one place"
  altogether means entirely, completely. The course was *altogether* successful

- **among/between**

  Use *among* when choices are more than two
  Use *between* only with two choices
  Between white and red, white is better. Among the different colors, white is the best

- **as regards/with regard to/in regard to/regarding**

  as regards and *regarding* are acceptable variants
  with regards to and *in regards to* are incorrect

- **beside/besides**

  beside means "next to" or "apart from"
  besides means "in addition to" or "other than"

- **bi/semi**

  bi means two; *bi*weekly means once in two weeks
  semi means half of; *semi*annual means twice a year

- **biennial/biannual/biweekly**

  biennial means once in two years
  biannual means twice during the year; but note that *biweekly* means once in two weeks

- **compared to/compared with**

  Compare something *to* a standard; but compare two unknowns *with* each other
  Compared to the local variety, the introduced variety performed poorly
  Compared with variety A, variety B performed better

- **complement/compliment**

  complement means support or "anything that completes a whole"
  compliment means praise

- **comprise/compose**

  comprise means contain, consist of
  compose means "create" or "make up the whole"

- **decrease/reduce**

  decrease means lessen in number (the number of plants decreased)
  reduce means lessen in amount (soil pH was *reduced* by lime application)

- **de facto/de jure**

  de facto means something "is a fact," and is accepted for practical purposes
  de jure means that something legally exists

- **despite/in spite of**

  No literal difference between these; *despite* means "in spite of"
  despite of is a wrong usage; use either d*espite* or *in spite of*

- **diagnosis/prognosis**

  diagnosis means an analysis of the nature of…, or conclusions reached by analysis
  prognosis means a forecast of prediction

- **differ from/differ with**

  differ from—suggests two things are not alike
  differ with—indicates disagreement between persons

- **different from/different than**

  In formal writing, the preposition *from* is used with different; d*ifferent than* is acceptable when it is followed by a clause

  This course is *different from* the previous course
  This course is *different than* the one we had before

- **discreet/discrete**

  discreet means having or showing prudent or careful behavior
  discrete means something separate, distinct, or individual

- **each and every**

  Each and every is commonly used in speech in an attempt to emphasize a point, but should be eliminated from writing; use either *each* or *every*, but not both together

- **fewer/less**

  Fewer refers to items that can be counted (*Fewer* plants survived than we expected)
  Less refers to mass quantities or amounts (mass nouns: *less* than usual rainfall)

- **good/well**

  The confusion about the use of good and well can be cleared up by remembering that *good* is an adjective and *well* is an adverb

  The student presented a *good* paper. The paper was presented well.

- **insure/ensure/assure**

  Assure refers to persons, and it refers to setting a person's mind at rest
  Ensure and insure also mean "make secure from"
  Insure is widely used in the sense of guaranteeing the value of life or property

  I *assure* you that the paper will be available'
  We need all the data to *ensure* the success of the project
  We should *insure* the home

  Use *insure* only when writing about a legal policy and *ensure* in all other instances

- **its/it's**

  It's is a contraction of *it is* (or, *it* has: see Sect. 6.10.9)
  Its is a possessive pronoun; it should be written without an apostrophe
  It's important that the results are published
  A book should not be judged by *its* cover

- **know-how**

  This is an informal term for "special competence or knowledge." It should be avoided in formal writing

- **lay/lie**

  The reason for the confusion between these two verbs is that *lay,* the past tense of *lie,* is also the present tense form of another word, and both sound similar

  Lay means "place" or "put." (Past and perfect tense: *laid*)
  Lie means "recline" or "remain." (Past tense: lay; perfect: lain)

  He *lays* the foundation of the building. Valuable information *lies* in old documents

- **like/as**

  like is a preposition and *as* is a conjunction; use *like* with a noun or pronoun that is not followed by a verb, and use *as* before clauses

  The new student behaves *like an expert*
  She behaves *as though she knows everything*

- **like/such as**

  Use *such as* instead of *like* to refer to specific examples
  Plants such as rice and wheat are called cereals

  Do not use etc. after *such as* and e.g.
  It is incorrect to say "Plants such as rice, wheat, etc. are called cereals"

  Similarly, it is incorrect to say "Plant growth was poor because of several reasons; e.g., lack of nutrients, poor drainage, etc."

- **objective/rationale**

  objective is the aim, goal;
  rationale refers to reason, justification

- **persons/people**

  The word "*persons"* refers to individual people thought of separately
  The word "*people"* refers to a large or anonymous group

  We need three qualified *persons* to help with measurements
  Many *people* have never even heard of the new professor

- **principal/principle**

  principal means an "amount of money on which interest is earned or paid" or a "chief official in a school or court proceeding"

  principle means a basic truth or belief

  The lead investigator in a research proposal is "Principal Investigator" (not "Principle Investigator")

- **precede/proceed**

  precede (verb) means go before; *proceed* (verb) means continue
  proceeds (noun) means revenue, income

  The wind preceded the rain
  We decided to proceed with the plan
  The proceeds from timber sale were used to support a scholarship

- **pseudo/quasi**

  As a prefix, *pseudo* means "false or counterfeit." It is joined to a word without a hyphen unless the word begins with a capital letter; e.g., pseudoreplication, pseudo-Americanism

  quasi means not complete, half, almost; e.g., quasi-permanent

- **raise/rise**

  Both *raise* and *rise* mean "move to a higher position"

  However, *raise* always takes an object (*raise* crops), whereas *rise* does not (heat *rises*)

- **since/because/for**

  since refers to sometime in the past to the present; *because* means, the reason is that "Since" is often used incorrectly instead of "because"

  Although the word *for* is still used instead of because, it is archaic

- **some/somewhat**

  some, an adjective or pronoun meaning "an undetermined quantity" or "certain unspecified persons," should not replace the adverb *somewhat* which means "to some extent"

  Change: "his writing has improved *some*"
  To: "his writing has improved *somewhat"* or "his writing is *somewhat* improved"

- **some time/sometime/sometimes**

  some time refers to a duration of time
  sometime refers to an unknown or unspecified time
  sometimes refers to occasional occurrences at unspecified times

We waited for *some time* before sending out a call for papers
The book will be published *sometime*
The editor *sometimes* gets irritated by the authors' lack of attention to details

- **stationary/stationery**

stationary means not moving, fixed
stationery refers to items such as paper and pencil

- **that/which**

These are words often used interchangeably, but sometimes incorrectly too

The word *which* introduces a nonrestrictive clause and such a clause can be removed without altering the meaning of the sentence

The word *that* introduces a restrictive or essential clause and such a clause cannot be removed without changing the meaning of the sentence

Plant a variety *that* is salt-tolerant. (Only some varieties are salt-tolerant)
Plant the Dwarf variety, *which* is salt-tolerant. (The Dwarf variety is salt-tolerant)

Do not drink water *that* is polluted
Do not drink lake water, which is polluted

Removing the clause "*that* is polluted" from the first sentence will alter its meaning; but removing "which is polluted" from the second sentence will not alter its meaning

The word *which* must have a comma before it and at the end of the clause it qualifies if it appears in the middle of a sentence. But there is no comma before *that* or at the end of the clause it qualifies

- **toward/towards**

Both *toward* and *towards* mean "in the direction of"; *toward* is more common in the United States, and *towards* in other places

- **whether or not**

whether by itself implies a choice between alternatives; it is redundant to use *or not* with whether

Wrong	The student wants to know *whether or not* she has passed the exam
Correct	The student wants to know *whether* she has passed the exam

- **when and if**

  when and if or *if and when* is a common colloquial expression that should not be used in writing. Use *when* or *if*

- **who/whom**

  When in doubt about which form to use, try substituting a personal pronoun to see which one fits

  If *he* or *they* fits, use *who*

  Who is the director of the Institute?
  He is the director of the Institute

  If *him, her,* or *them* fits, use *whom*

  It depends on *them*
  It depended on *whom*?

Chapter 6
Sentences

Abstract Good scientific writing involves use of simple terms and sentences to communicate even a complicated subject. Complex, hard-to-understand sentences are rarely good, and repeated use of unnecessarily difficult words and phrases makes the subject hard to understand. Some important issues of this nature considered in this chapter are: active vs. passive voice, tense, parallel structure, double negatives, disguised writing, complex sentences, wordiness and conciseness, transition between sentences and paragraphs, and punctuation marks.

> *A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts.*
>
> —William Strunk, Jr.

A good writer will choose a concrete word in preference to an abstract one and a familiar one instead of a rare one, be as definite and specific as possible, and avoid vague statements. Some issues that are important in this context are considered in this chapter.

6.1 Active and Passive Voice

Many books on English style and grammar checks in word-processing software recommend the use of active voice because passive voice may make the text boring and dull, add words, reduce impact, and cause confusion. Given below are two simple examples of passive and active construction:

Passive	In this study, the second procedure was followed.
Active	In this study, we followed the second approach.

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_6,

Passive The procedure is illustrated in Fig. 2.
Active Fig. 2 illustrates the procedure.

In spite of the above-stated advantages of active voice, passive voice is also commonly used in scientific style. For example, the expression "the soil was analyzed" (passive) will sound as good as or better than "we analyzed the soil" (active), because most of the time the subject is you, the researcher, and the readers do not need to be told that "you" analyzed the soil. Thus, while it is better to use active voice where it fits, passive voice is not to be completely discarded.

6.2 Tense

As described in Chap. 2, past tense and present tense are used in different segments of scientific papers depending on what is presented. The Introduction and the Discussion sections will have a mixture of past and present tenses, whereas the Materials and Methods and the Results sections are reported in past tense. Future tense is used only for making predictions or describing future work; e.g., "The results mean that adoption of agroforestry practices will lead to enhanced biodiversity."

6.3 Parallel Structure

This refers to using similar forms for expressing similar ideas or elements of a sentence. The following examples illustrate the common situations:

NO The objectives were "to assess the extent of damage, to identify the causes of the problem, and recommending remedial measures."
YES The objectives were to "assess the extent of damage, identify the causes of the problem, and recommend remedial measures." OR The project was conducted with the objectives of "assessing the extent of damage, identifying the causes of the problem, and recommending remedial measures."

NO The farmer is busy to harvest, sorting, and he will pack the fruits.
YES The farmer is busy harvesting, sorting, and packing the fruits.

Whenever "and" or "or" is used in a sentence, each must connect equal parts; i.e., words paired with words, phrases with phrases, clauses with clauses, and sentences with sentences; and all pairs must have the same form.

NO The sample was collected, stored, and then it is analyzed.
YES The sample was collected and stored, and then analyzed.

NO The students visited the field, labs, and even saw the library.
YES The students visited the field, the labs, and even the library.

Pairs of connectives, such as *both/and, either/or, neither/nor,* and *not only/but also*, usually connect parallel structures.

NO The person was both helpful and he knows all the details.
YES That person was both helpful and well informed.

NO "You may either buy the book, or it is in the library."
YES "You may either buy the book, or borrow it from the library."

NO "You not only should collect the data, but results also should be discussed."
YES "You should not only collect the data, but also discuss the results."

6.4 Double Negatives

Two negatives or negative words make a positive statement. For example: "It is not unlikely" means "It is likely." Although this sort of construction is common, it is convoluted and often gets in the way of plain speech. Sometimes there is a fine difference in meaning between a positive statement and a double-negative one; for example,

The total was not unimpressive. [It was impressive.]
Here the reader might miss the word "not" and misunderstand the meaning.

At no time was the student absent. [The student was always present.]
This is verbose; it uses extra words to say a simple thing in a more complicated way.

6.5 Disguised Writing

Disguised writing includes awkward positioning of clauses, presenting positive information in a negative sense (and vice versa), and excessive use of negative words. These can confuse and misguide the reader.

Example 1 (Awkward positioning of clause):

"Our research has shown that although the presence of trees could influence the understory microclimate in a mixed stand, the presence of trees had little influence on disease incidence in the understory species."

Rewrite as:

"Although the presence of trees could influence the microclimate of the understory species in a mixed stand, our research has shown that the presence of trees had little influence on disease incidence in the understory species."

Example 2 (Gaps between subject and its verb):

> "A solution to the complicated problem of how to manage the sequence of occurrence of various components of this complex issue has been discovered."
>
> Rewrite as:
>
> "A solution has been discovered to the complicated…" or
> "A team of scientists at …discovered a solution to" …

Example 3 (Excessive use of negatives):

> "If the research does *not* involve live animals, the special forms need *not* be submitted."
> "The special forms need to be submitted only if the research involves live animals."
>
> In the first sentence, the exception to the rule is clear only after passing through two layers of negatives; the second sentence presents the exception in a direct manner.

Example 4 (Presenting a negative result as though it were positive):

> "Carbon emission levels were maintained to 10 percent higher than acceptable levels."
> "Carbon emission levels continued to be 10 percent higher than acceptable levels."
>
> The first sentence tries to downplay the fact that carbon emission levels continued to be higher.

6.6 Complex Sentences and Indirect Language

Sentence fragments: Sentence fragments that are missing a subject or a verb and are common in conversations may be avoided in scientific writing. This can be done by either supplying the missing part or attaching the fragment to the preceding or succeeding sentence.

Example:

> NO Because there was no rain. That is why the crop failed.
> YES The crop failed because there was no rain.

Sentence fragments might, however, be quite effective as questions and exclamations. When properly used, they can add some emphasis or liveliness, which

could be important in some situations. But it is generally best to avoid using these in scientific writing.

Garbled*, *long*, *and rambling sentences: A *garbled sentence* is one that is so tangled with structural and grammatical problems that it cannot be repaired by simply replacing words or rewriting phrases. The following is a sentence in the Preface to a book manuscript submitted for publication:

> "There is a global consensus that integration of trees/perennials into farms, grazing lands and other production landscape helps to promote social, economic, cultural, ecological and environmental benefits, with these developments in agroforestry science we are now in better position to capitalize promise of multi-functional agriculture to make a difference in the lives of million of people across globe and sustainable environment."

The ideas contained in the sentence could be better conveyed by modifying it as:

> "A global consensus is emerging that integration of trees into farms and grazing lands helps to enhance the social, economic, cultural, ecological, and environmental benefits to the land and the land-user. With the recent developments in agroforestry science, we are now in a better position than ever before to capitalize on the promise of multi-functional agriculture and make a difference in the lives of millions of people across the globe and create a sustainable environment."

Long and rambling sentences: There is no unanimity of views on how long is too long! A good rule to follow is that if a sentence runs on for more than three typewritten lines, it is probably too long! Some experts recommend a mixture of short and long sentences to add variety and improve the rhythm of writing. Sentences become too long when too much information is packed into a single sentence. Even if there is nothing grammatically wrong with a long and rambling sentence, by being too long, it interferes with the reader's comprehension. For example, the following is from a book proposal:

> "The volume has been widely divided into 6 Sections covering up to date information on different subjects of scientific and professional merit and relevant to science and practice of agroforestry worldwide, and it will be useful for engaging more stakeholders, including students, foresters, farmers, local communities, indigenous peoples, civil society institutions, the media, the private sector, scientists (working in the field of Agroforestry, Forestry, Life Sciences, Animal Husbandry & Dairy, Social Science, Food Science and Environmental Sciences), policy makers, the leadership, and the public."

Several things are wrong with the sentence. Breaking it up, adding proper articles and punctuation, and deleting the redundant words will make the text more understandable:

> "The book will be divided into six sections covering current information on different aspects of the science and practice of agroforestry worldwide. It will be useful to a wide spectrum of stakeholders, including students, foresters, farmers, local communities, scientists, and policy makers in disciplines and fields related to agroforestry."

Given below is another example of a long sentence. Several ideas are packed into one sentence such that the sentence is tedious to read.

"Unfortunately, the modernization (i.e., transformation from agricultural to industrial reliance) typically accompanying population movement is not occurring in African countries, hastening the decline of already deplorable urban living conditions, with environmental concerns resultant of climate change and agricultural expansion pursuant of sustenance for ever-increasing rural populations further complicating the manner in which the necessary agricultural intensification can take place."

6.7 Wordiness/Conciseness

If I had more time, I would have written a shorter letter

—attributed to Mark Twain.

Wordiness refers to excessive use of words in writing and it results from poor choice of words to express the ideas or repetition of the same idea in different words.

Example:

> "Modern agriculture *of today* is more technologically sophisticated than that of 50 years ago." ("of today" means "modern" and can be dropped)
> The corrections are marked in red *color* ("color" is redundant here).

Causes of wordiness: Wordiness results from lack of care or judgment in the use of words. Some common examples are given below.

- Modifiers that repeat the idea that is already present in the word (examples of such modifiers are in italics in the following):
  personal opinion, *past* history, *final* outcome, the reason *is because* …

- "it … that" construction that also leads to use of passive voice:

  "*It* is agreed *that* our new professor is a scholar."
  "We agree that our new professor is a scholar."

- Use of synonyms:
  each and *every*, *basic* and *fundamental*, *last* and *final*, …

- Excess qualification:
  utterly rejected, *completely* accurate, *radically* new, *accurately* correct, …

- Circumlocution (long and indirect way of expressing things):
  "The proof-correction that is due within five days should be done promptly so that in the event of a delay in publication of the paper, we may not be held in default of our responsibility as authors by virtue of not complying with the publisher's directives."
  Modify as:
  "Correct and return the proof promptly so that we, the authors, will not be held responsible for any delay in publication of our paper."

Table 6.1 Examples of simple words to replace long word strings

Use	Instead of using
To	In order to, so as to, so as to be able to, with a view to
Because	Due to the fact that, for the reason that, owing to the fact that, the reason for
By or with	By means of, by using, through the use of
Now	At this time, at this point in time, at present
Then	At that time, at that point, at that point in time, as of that date
Soon	In the near future
Usually, normally	More often than not
Consider	Take into consideration
Adjust	Make an adjustment
Suggests	Would seem to suggest
Regularly	On a regular basis

Conciseness is not a synonym for brevity. Conciseness is always desirable, but brevity may or may not be desirable depending on the context. Excessive brevity will lead to "telegraphic language," which is not desirable in scientific writing. A concise sentence is not necessarily effective, but a wordy sentence lacks readability and may lose some of its intended meaning. Furthermore, a fine line exists between being concise and being polite. If a text is not understandable, a written response "I don't understand it" would probably be offensive; asking for more information on that text would then be more desirable.

Conciseness, however, should not be overdone. An anecdote about conciseness is worth mentioning here: "Applicants to a famous competition were asked to write a concise essay involving 'Religion, History, Majesty, and Mystery.' The winning essay was 'The queen got pregnant; no one knows who is responsible for it!'"

6.7.1 Achieving Conciseness

It follows from the earlier statement that "wordiness results from poor choice of words to express the ideas or repetition of the same idea in different words" and that conciseness can be achieved by effective use of appropriate words. In addition to what have been described earlier, ways of achieving conciseness include the following:

- Eliminate wordy and pretentious words and phrases such as:

  As you may recall, *In view of the foregoing*, *As you know*, *Needless to say*, *It may be said that*, *In view of the fact that*, *It is interesting to note that*, …

- Avoid overuse of intensifiers such as: *very*, *more*, *quite*, *rather*, …
- Substitute long word strings with simple words: see Table 6.1.

6.7.2 *Verbosity: Unnecessary and Difficult Words*

Verbosity, a form of wordiness, refers to saying a thing in a complicated way, with lots of words, usually to make it sound more important. The purpose of a scientific paper is to inform readers, not to impress them with the writer's vocabulary skills. For example, "Although the efficacy of the chemical fertilizer in augmenting plant growth is undeniable, it is a fallacy to accept the assertion that its unrestricted and generous use cannot exacerbate the problems of non-point source pollution and adversely impact long-term ecosystem sustainability" means "While the use of chemical fertilizers can enhance crop growth, their excessive and continuous use may cause pollution of water bodies and thus affect ecosystem sustainability."

6.8 Transition

Transition in this context refers to smooth flow of ideas from sentence to sentence, paragraph to paragraph, and subject to subject. Transition is a sort of road-map to the reader. It is a two-way indicator of what has been said and what will be said; i.e., it provides a means of linking ideas to clarify the relationship between them. Transition can be accomplished with a word, a phrase, a sentence, or even a paragraph.

Example:

> "Having confirmed the economic benefit of introducing this variety, we now turn to the issue of inadequate seed supply."
>
> Or it can be said more subtly:
>
> "The variety is economically attractive; but, inadequate seed supply could be an issue."

Either way, the reader's attention is brought to the problem of inadequate seed supply, which is the message of the sentence.

Transition between words: Several transitional words are available for specific contexts:

Result	*therefore*, *as a result*, *consequently*, *thus*, *hence*
Example	*for example*, *for instance*, *specifically*, *as an illustration*
Comparison	*similarly*, *likewise*
Contrast	*but*, *yet*, *still*, *however*, *nevertheless*, *on the other hand*

Addition	*moreover*, *furthermore*, *also*, *too*, *besides*, *in addition*
Time	*now*, *later*, *meanwhile*, *since then*, *after that*, *before that time*
Sequence	*first*, *second*, *third*, *then*, *next*, *finally*.

The use of such transitional expressions helps clarify and smoothen the movement from idea to idea. Conversely, the lack of transitional words can make the reading tedious. For example, consider the following two paragraphs; the first is without transition; the second is with transition *in italics*:

> "Scientists had always hoped to do calculations rapidly. In the past, electronic computing was only a dream. Most people thought that calculations were meant to be done only manually. Electronic calculators and computers were introduced in the 1960s (*or whenever*!). Electronic computing has become part of our everyday work."

> "Scientists had always hoped to do calculations rapidly, *but* it was only a dream in the past. *Then (or, at that time)*, most people thought calculations were meant to be done only manually. *In the 1960s, however,* electronic calculators and computers were introduced. *Since then* electronic computing has become part of our everyday work."

Transition between sentences: In addition to using transitional words and phrases, effective transition between sentences can be achieved by repeating key words or ideas from preceding sentences, using pronouns that refer to antecedents in previous sentences, and repeating the pattern or parallel structure of phrase or clause. Consider the following short paragraph about a hypothetical example, in which all these means are employed.

> "Town X" is a typical example of many small towns in the State of "Y". *This coastal town*, formerly a *sleepy fishing community*, is today the home of "Z University" with a vibrant *academic community*. Attracting students from all over the region, *the university* has grown very rapidly during the past decade. Recognizing *this expansion*, the state has helped in the acquisition of land adjacent to the University for expanding its physical facilities. *The university* has become the major economic activity, generating most of *the town's* income, and causing some of *its* new problems too."

Transition between paragraphs: All the means discussed above for achieving transition between sentences may also be effective for transition between paragraphs. Repetition of key words or ideas may be particularly effective. For paragraphs, however, longer transitional elements may be required. The common techniques for accomplishing transition between paragraphs include:

- Use tactically, without sounding repetitive, an opening sentence or clause that summarizes the preceding paragraph before proceeding with the business of the new paragraph
- Ask a question at the end of one paragraph and answer it at the beginning of the next
- Insert a transitional paragraph to enhance readability
- Use numbering patterns that clearly show continuity of sections.

6.9 Awkwardness

Ending a sentence with a preposition is something up with which I will not put.

—Winston Churchill

Any writing that the reader finds complicated and difficult to understand is awkward. In other words, if a reader for whom the article is targeted finds it tedious to read and unnatural to the extent of impeding comprehension, the article is awkward.

The following email from an academically good graduate student after a recent meeting of his supervisory committee is a good example of awkward writing:

> "Thanks for your valuable input in committee meeting today. I am trying to improve my writing skill. I will get involve with this intensely once I will start writing one of my research article. I would like to improving in these area. I would appreciate any kind of suggestions or advice or help in this regards. Thanks."

Awkwardness has many causes, including all the issues discussed in this chapter, and more: overloaded sentences, overlapping subordination, grammatical errors, ambiguous statements, overuse of passive voice, faulty logic, unintentional repetition, garbled sentences, jammed modifiers, and so on. The tendency to use "buzz" words and phrases that are considered fashionable but poorly defined has always been popular among many young and inexperienced writers. Good writing will present what the author wants to say in the simplest, most direct way.

In addition to the grammar and syntax problems that are all too common with the writing of many, some awkward expressions and features of writing seem to be associated with certain groups of writers. Without going into the rules of English grammar, here are some such expressions:

- Improper and inadequate use of articles "a" (or "an") and "the" before the noun. This is a common problem with the writing of many authors from countries that had previously been under British rule. Although they start learning English at a very young age and most of them have good comprehension of English, and English is the medium of higher education in most such places, many writers have a tendency to leave out the articles altogether or use them improperly. An excerpt from the Preface of a recent book manuscript quoted in Sect. 6.6 states: "… we are now in better position to capitalize promise of multi-functional agriculture to make difference in the lives of million of people across globe…"
- Incorrect use of singular instead of plural noun while referring to one out of a multiple group: "one of the *reason* for …," "one of his *paper* …," "one of my *objective* is …, and so on. (All nouns in *italics* in these examples should be in plural forms.)
- Conjunction—preposition awkwardness: "Although…, but …": *Although* the rains were less than normal and irrigation was inadequate, *but* the crop was good. (Either the "*although*" or the "*but*" should be dropped.)

- "As reported in literature *that* … nitrogen fixation is impacted by …,", "As has been established *that* phosphorus retention capacity of soils is determined by …," and so on. (The "*that"* is unnecessary and awkward in such sentences.)

Arguably, the reason for some of these problems is the differences in grammar and sentence construction between English and the writers' native languages; the writers tend to think in their native languages and then express the thoughts in English.

It has become customary for editors and reviewers of many journals to ask the authors to get their manuscripts reviewed by "native English speakers" and some writers get offended by such general lashing. Native speakers of any language need not necessarily be superior writers! Such editors and reviewers may be doing a better job by asking for improvement of English and leaving it to the authors to decide how to get that accomplished. The authors, on their part, should try to understand the message and ignore the way it is delivered.

6.10 Punctuation Marks

Punctuation marks may link, separate, enclose, indicate omissions, terminate, and classify sentences, and most of them can perform more than one function. The use of punctuation is determined by grammatical conventions and the writer's intention—in fact, punctuation often substitutes for the writer's facial expressions. Misuse of punctuation can cause the reader to misunderstand the intended meaning.

The English language has 14 marks of punctuation that help the reader understand a sentence:

Apostrophe	'
Brackets	[ ]
Colon	:
Comma	,
Dash	– —(en-dash and em-dash)
Ellipsis	…
Exclamation point	!
Hyphen	-
Parentheses	( )
Period (Full stop)	.
Question mark	?
Quotation marks	" "
Semicolon	;
Slash	/

Some of these, especially apostrophe, ellipsis, exclamation point, and question mark are relatively less used in scientific writing. Some examples of the use and misuse of the major marks of punctuation are illustrated below.

6.10.1 Comma (,)

Like all punctuation, the comma helps readers understand the writer's meaning and prevents ambiguity. The most "classical" example of the relevance of comma is perhaps the sentence below (or some variant of that):

> "Democrats say Republicans will win the next election."
> Insert two commas as shown below and see how the meaning of the sentence changes completely:
> "Democrats, say Republicans, will win the next election."

Notice how the comma helps make the meaning clear in the following examples:

Consider	"To be successful scientists with PhDs must continue to learn."
Vs.	"To be successful, scientists with PhDs must continue to learn."

The first sentence seems to be about "successful scientists with PhDs." The comma makes clear where the main part of the sentence begins.

Serial comma refers to the comma before the final *and* or *or* before the final item: for example: in "A, B, C, and D," the comma after C is the serial comma. There is no unanimity of "rules" on the use of serial comma; some writers and journals use them; some don't. In general, the serial comma is used in US English, but not used in UK English. The advice to writers is: "Follow the journal's style."

6.10.2 Period (.)

A period ("full stop" in British English) is used at the end of a sentence. It is also used at the end of some abbreviations such as "etc." and "sp." (species, singular), but ***not*** after units (kg, cm), chemical symbols (HCl, CO_2), or acronyms/abbreviations (FAO, UNESCO). In British style, a full stop is not added after an abbreviation where the last letter is the same as the last letter of the full word (*Dr, Mr,* etc.) whereas in US style, a period is added in such cases (*Dr., Mr.*, etc.). A period is added after "spp." to indicate the plural form of species after Latin names of plants, e.g., (*Leucaena* spp.); some journals, however, allow a period only after sp. (singular) but not after spp (pural); thus, *Leucaena* sp. (one species of the genus *Leucaena*) and *Leucaena* spp or *Leucaena* spp. for multiple species of the genus *Leucaena*). For

academic degrees and geographical names, periods are optional; but be consistent (Ph.D. or PhD ***not*** "Ph.D" or "PhD."; USA or U.S.A., ***not*** "U.SA." or "US.A.").

There is no unanimity of views on the number of spaces after a period. It used to be a common norm while using typewriters to leave two spaces after the period between sentences to clearly indicate the end of the sentence (especially to the typesetter). But word processors use proportional letter spacing; so, end of a sentence is clear; therefore, nowadays, only one space is left in such situations. See Sect. 4.2. for the norm about space between a numeral and the unit that follows it.

6.10.3 Quotation Marks (" ")

Quotation marks, sometimes referred to as "double quotation marks" [to distinguish them from single quotation marks (' ') that are sometimes called "inverted commas"] are used around words to indicate that they are "special," meaning that they are newly introduced to the context or quoted from someone else. Usually, double quotation marks are used outside such words at the beginning and end, and single quotation marks are used within the double quotation marks to refer to something specific within the quote covered by the double quotation marks. All punctuation marks are placed inside the quotation marks if they are part of the quote. A major difference between the US and British versions of English is that in US English, comma (,) and period (.) are placed inside the quotation marks, but colon (:) and semicolon (;) are placed outside the quotation marks; in British English, all punctuation marks are placed outside the quotation marks.

Examples:

> The survey questionnaire has three options: "Yes," "No," or "No opinion." (US English)
> The survey questionnaire has three options: "Yes", "No", "No opinion". (British English).

Question marks and exclamation points go outside the quotation if they apply to the entire sentence, and inside if they apply only to the quoted part. In either case, if the question mark or exclamation point comes at the end of the sentence, there will be no period after that because a sentence cannot have more than one terminal punctuation mark.

Examples:

> That scientist is considered a "living legend"! (The entire sentence is exclamatory)
> The issue is "Can he be considered a living legend?" (Only the quoted part is a question).

6.10.4 Hyphen (-)

Although the hyphen functions primarily as a spelling device, it also functions to link and to separate words.

- The most common use of the hyphen is to join compound words.
  Examples: able-bodied, self-contained, carry-all, brother-in-law
- Occasionally a hyphen (or dash) replaces the preposition *to* (0–100 for 0 to 100) as described in Sect. 4.1
- A hyphen is used to form compound numbers from twenty-one to ninety-nine and fractions when written out; examples: twenty-seven, one-tenth
- *Hyphens Used with Modifiers*:
  - Use a hyphen to join words used as a single adjective
    Example: four-year-old-tree [NOT four-years-old- tree] or four year-old-trees
  - Two-word and three-word unit modifiers that express a single thought are hyphenated when they precede a noun (an *out-of-date* car, a *clear-cut* decision)
  - If each of the words can modify the noun without the aid of the other modifying word or words do not use a hyphen (a *new digital* computer—no hyphen)
  - Also, if the first word is an adverb ending in *-ly*, do not use a hyphen (a *hardly* used computer, a *highly* desirable event).

- The presence or absence and position of a hyphen can alter the meaning of a sentence.

Example: “Indigenous crop management practice” could mean:

“Indigenous-crop management practice” (management practice for indigenous crop), or “Indigenous crop-management practice” (indigenous practice of crop management), or either of the two in the absence of a hyphen.

- A modifying phrase is not hyphenated when it follows the noun it modifies.
  Example: The equipment is *out of order.*
- A hyphen is always used as part of a letter or number modifier.
  Examples: 5-cent, 9-meter, A-frame, H-bomb
- In a series of unit modifiers that all have the same term following the hyphen, the term is added only at the end of the series.
  Example: Instead of “The third-row, fourth-row, and fifth-row plants were harvested,” write “The third-, fourth-, and fifth-row plants were harvested”.
- *Hyphens Used with Prefixes and Suffixes*
  - A hyphen is used with a prefix when the root word is a proper noun.
    Example: pre-Darwin, anti-Soviet, post-Einstein

  - A hyphen is used when *ex-* means "former."
    Example: ex-president, ex-husband
  - The **suffix-***elect* is hyphenated: president-elect, commissioner-elect
- Some words and modifiers should always be hyphenated to avoid confusion: for example, *re-sent* versus *resent*; *re-sign* versus *resign*, *re-cover* versus *recover*.

6.10.5 Dash (—)

A dash is used to emphasize a break in thought or a turn in content. Two types of dashes are commonly used: **en dash** (–) and **em dash** (—). The en dash is roughly the width of the capital letter N in whatever font that is used, and the em dash has the width of the letter M. There are also 2-em dash and 3-em dash, but these are seldom used in scientific writing. Sometimes the dash is confused with the hyphen. A dash is not a hyphen, nor is it a keyboard character; two consecutive hyphens without a space in between will form a dash. See Sect. 4.1 about the use of a hyphen to indicate a range of numbers.

Dashes when used to set off elements as descriptions and examples function much as commas. But when such elements are not integral to the sentence or when they consist of a series of commas to separate out sub-elements, the dash would be the useful and appropriate punctuation mark to use.

- Dashes could be used with or without leaving a space at either end: "The crop grew well—the rains helped—and so did the weeds." OR "The crop grew well–the rains helped–and so did the weeds."
- Do not put a comma or semicolon immediately adjacent to a dash even if the text that is broken by the dash would otherwise have it: "In spite of heavy rains, which were unseasonal, the field work could be completed as planned." "In spite of the heavy rains—which were unseasonal—the field work could be completed as planned."

6.10.6 Colon and Semicolon

A ***colon*** (:) is used to join two independent clauses when the second clause explains or restates the first, or to separate a main clause from a list.

Examples:

The manuscript was rejected: the experiment was flawed.
Two questions remain: how do we do it, and when?

A ***semicolon*** (;) is used to join two closely related independent clauses when a comma would be insufficient or unclear, or to separate items in a series when the items contain commas.

Examples:

The student's excuse sounded too good to be true; the professor did not accept it.

The trials were conducted in locations A, B, and C; but the results from location C were not available.

6.10.7 Brackets ([]) and Parentheses ()

These punctuation marks are often used interchangeably and referred to erroneously.

Brackets, sometimes referred to as square brackets "[ ]", are used to make additions or comments to quoted material that is not part of the original quote, or to provide explanatory information. For example, if a quotation contains a misspelling or an error, the writer may want to make it clear to the readers that "this is the way it appears in the original" by adding *sic* (in italics, but not capital letters) in brackets immediately after that misspelling or error. Sometimes, when a passage is put down verbatim, it may contain a pronoun (his, she, it, those) that may not be clear, and it may therefore be necessary to replace the pronoun with the referenced word or name in brackets.

Examples:

"Crop yields in plot A was [*sic*] poor."
Original quotation: "We all expected it to be accepted for publication."
Revised: "We all expected it [the manuscript] to be accepted for publication."

Note: *sic* is the Latin word for "so" or "thus"; its use within brackets as above means "it appeared thus in the original" (see Table 4.2).

Parentheses "( )" are used to make the complex sentence easier to follow and to set off words, phrases, or even sentences used to explain the main idea.

Examples:

The mean temperature during the study period (Table 1) was lower than the 30-year average for the location (24 °C).

Norman Borlaug (1914–2009) was the only agricultural scientist to be awarded a Nobel Prize.

Silvopasture is the most common agroforestry practice of the region (others include shaded perennials and homegardens).

Some common rules about the use of brackets and parentheses:

- Do not use spaces around the enclosed text (not like this), but (like this).
- Avoid using double parentheses within parenthetical text; use brackets instead: (sample 1 [N = 24] and sample 2 [N = 34] were …)
- The terminal punctuation mark should be inside the parentheses when the parentheses enclose a sentence that stands alone; but put the terminal punctuation mark outside the parentheses when the parentheses enclose only a part of the sentence.

  The committee unanimously approved the variety for release. (Some members were not too happy about it!)
  The committee unanimously approved the variety for release (although some members were not too happy about it).

- Even if the parenthesized element is a complete sentence, do not begin it with a capital letter, and do not end it with a period.
  The committee unanimously approved (some members were not too happy about it) the variety for release.

6.10.8 Slash (/)

A slash, also called slant line or *solidus,* is an imprecise and informal mark that is commonly used to indicate options, alternatives, "and" or "or" relationship, or to connect two distinct entities (e.g., audio/video, washer/dryer). In scientific writing in agriculture and natural resources, it is commonly used, especially in extension literature, to mean "per" with units of measurements (e.g., 25 kg/ha). Expressions such as kg/ha/yr are perhaps clear enough. In equations, however, a slash will mean "divided by"; for that reason, use of more than one slash in an equation or expression becomes mathematically ambiguous: "a/b/c" could mean "a" divided by "bc" or "ac" divided by "b". Therefore, in scientific writing, the slash should be avoided, and replaced by negative exponential to express "per" (kg ha^{-1} - $year^{-1}$ instead of kg/ha/year)—see also Sect. 4.1.

A slash and a hyphen between two words do not have the same effect; the function of the hyphen is to create a compound word; with a slash, both words retain their independence.

6.10.9 Apostrophe, Ellipsis, Exclamation Point, Question Mark

These marks of punctuation that are commonly used in general and journalistic writing are rarely used in scientific writing.

An ***apostrophe*** (**'**) is used to indicate:

- possession (animal's DNA, student's computer)
- omission in contracted words ("it's" for "it is" or "it has", "don't" for "do not")
- plural forms in some situations ("A's"—not to confuse with "As").

The apostrophe is, however, misused commonly. As mentioned above, "it's" means "it is" or "it has"; it *does not* mean "its" (which means "belonging to it"). Similarly, "1990's" means belonging to 1990; "1990s" is the correct expression for the decade 1990–1999.

English grammar has specific rules for use of apostrophe. For example,

- For plural nouns that end in *s*, add just an apostrophe (trees' height)
- For plural nouns that do not end in *s*, add an apostrophe plus *s* (children's books)
- For joint possession, add apostrophe after the last noun (crops and trees' environment)
- For separate possession, add apostrophe after each noun (crop's and tree's growth habits).

In scientific writing, however, use of apostrophe may be avoided if possible:

- Write "it is" or "it has" as the case may be instead of "it's"
- Write "growth habits of crops and trees" instead of "crop's and tree's growth habits"
- 1990s instead of 1990's (to indicate the decade of 1990–1999).

An ***ellipsis*** (…) comprises three dots and is used to indicate that one or more words have been omitted, especially within a quoted material, or sometimes for imparting extra significance to a sentence. This is seldom used in scientific writing.

An ***exclamation point*** (**!**) is used to indicate added importance, emotion, or rhetorical statements. Such expressions have practically no place in scientific writing.

A ***question mark*** (**?**) indicates a query or uncertainty, and sometimes a rhetorical question. Again, this has only limited (if any) use in scientific writing.

In conclusion, sentence construction is an extremely important aspect of scientific—indeed, any—writing. A summary of the main points related to it is presented in Table 6.2.

Table 6.2 Summary of important points related to sentence construction

Section	Subject	Recommendation
6.1	Active Versus Passive Voice	Active voice is preferred; but passive voice has its place too
6.2	Tense	Mixture of past and present for Introduction and Discussion; past tense for Results; future tense for predictions
6.3	Parallel Structure	Use similar forms for similar ideas or elements of a sentence
6.4	Double Negatives	In general, avoid double negatives
6.5	Disguised Writing	Includes awkward positioning of clauses, inverted statements, excessive use of negatives, etc.; avoid it
6.6	Complex Sentences	Sentence fragments (missing a subject or verb), long and rambling sentences; avoid them
6.7	Wordiness, Conciseness, Verbosity	Excessive and poor choice of words to express ideas; to achieve conciseness, substitute long word strings with simple words, avoid overuse of intensifiers, eliminate wordy text
		Verbosity is using too many words, a form of wordiness
6.8	Transition	Smooth flow of ideas between sentences, paragraphs, and subjects. Use transitional words where appropriate
6.9	Awkwardness	Any writing that the reader finds complicated and difficult to understand is awkward
6.10	Punctuation Marks	Out of the 14 marks, ellipsis, exclamation, and question mark are relatively less used in scientific writing
	Comma	Proper use prevents ambiguity
	Period	End of sentences and some abbreviations, not after SI units
	Quotation Marks	Used around words to indicate that they are "special"; all punctuation marks that are part of the quote to be within quotation marks
	Hyphen	A spelling device; also used to link or separate words
	Dash	To emphasize a break in thought; not to be confused with hyphen; en dash (width of N) and em dash (width of M) are used; no comma or semicolon adjacent to a dash
	Colon and Semicolon	Colon used to join two independent clauses when the second clause explains the first; semicolon used to join two closely related independent clauses
	Brackets and Parentheses	Brackets used to make additions to quoted material; parentheses to make complex sentences easier to follow
		Avoid double parentheses within parenthetical text
	Slash	An informal mark to indicate options and alternatives; also used instead of "per" with units of measurements. Being an imprecise mark, better to avoid in scientific writing
	Apostrophe	To indicate possession or omission in contracted words; commonly misused; avoid in scientific writing if possible

Part III
Manuscript: Preparation, Submission, and Follow-up

Chapter 7
Preparing the Manuscript

Abstract Writing and publishing a paper always takes more time than originally estimated. Definite instructions are not available on when and in what order the different sections of a paper should be written. The most recommended strategy is to formulate a plan for the paper and start assembling its essential parts as the research progresses and develop a schedule of who (if there are coauthors) does what and when. Be clear about the scope of the paper and the message to be delivered, and consider the requirements and norms of the journal to which the paper is planned to be submitted. Preparing a first draft, revising it repeatedly, and getting it reviewed by colleagues are the time-tested steps followed in preparing a research paper.

Writing a scientific paper is a tedious task involving several steps. The views on issues such as what a good scientific paper should contain and how the various sections should be arranged are somewhat unanimous, and several books and other instructional materials are available with descriptions on such topics (see the section: References and Recommended reading). No such unanimity of views or definite instructions are available on when and in what order the different sections of the paper should be written and put together. It is generally accepted, however, that writing always takes more time than initially anticipated and that nobody writes an entire paper in one sitting, no matter the reputation and experience of the writer. The instructions and suggestions contained in this section are therefore of a more general nature than those of the previous sections of this book.

Two points made earlier in this book are worth repeating here:

1. Publication of research results is an essential part of the scientific endeavor; no research project is considered complete until its results are published appropriately and adequately.
2. The time needed for writing and publishing the results is almost always underestimated. This is usually the case while planning and time budgeting for research projects, and it often leads to administrative problems later. The

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authors of this book have had numerous experiences of the difficulties faced by doctoral students and visiting scholars, who struggle very hard and work against the clock to complete and submit their papers to journals within the strict—often funding-related—time limits.

7.1 When to Write

Although writing represents the last stage of a research project, its initiation need not—and, should not—be pushed to the very last stage of the research. Indeed, several sections of the paper such as Introduction, Materials and Methods, and References can be brought to near completion before the graphs and tables incorporating the last set of results are ready. It is a good idea to develop a plan for publications out of the project and start assembling the essential parts of the paper according to the IMRAD format (Chap. 2) when the research has advanced enough and reached a distinct phase.

Before embarking on writing a paper, the researcher needs to be sure that adequate information is available for a new paper. It may be risky to put in a lot of effort in writing a paper focused on results that are expected to come in "soon" from project activities that are subject to unforeseen difficulties (e.g., weather-dependent field surveys and experiments in field).

It is extremely important that the results are published in a timely manner. Results become obsolete with time. In academia, it is a common norm that if the results of a graduate study (MS or PhD) are not published as peer-reviewed journal articles within three years of the candidate's graduation, then it will be difficult to publish the study, and it may not be even worth publishing. The authors of this book are familiar with several such cases where good-quality graduate studies have, unfortunately, been not published. Similarly, conference/workshop proceedings published as peer-reviewed products (books or special issues of journals) will be "dead on arrival" if they are not published within 2 years of the actual event.

7.2 How to Proceed

As mentioned at the beginning of this chapter, there are no "standard" rules and set procedures on how to proceed with writing a paper. It is basically up to the authors to decide the best way of doing it. When multiple authors are involved, it is important that there is a clear understanding of who is doing what, and one person—usually the first author—coordinates the efforts. The common steps involved in writing a scientific manuscript are discussed below, but not in any definite sequence.

7.2.1 Overcome the "Fear" Complex

A person who has never made a mistake has never tried anything new.

—Albert Einstein

Perhaps there is no exception to the general rule that every scientist, no matter how outstanding and respected they are, had to go through the "fear" complex about their first paper/s. As the time for writing comes, the writer faces several stressful thoughts, concerns, and anxieties, all going around in circles repeatedly: "where will I start, what will my supervisor and friends think about my writing, how can I put all these things together, how will my paper match with those of my colleagues," and so on. Be assured, however, that you are not the only one who has experienced this "trauma"; everybody before you had to go through it and everybody after you will experience it too. It is something like learning to walk: no child learns to stand on his/her feet and walk without falling down several times. A part of this fear complex is your earnest desire for the paper to be perfect in every sense at the first attempt. It is a good idea to have it as best as possible. But a research paper is *not* normally completed in a single attempt. If you wait for even the draft to be perfect in every respect before it is given for reading to someone else, you probably will never publish a paper. This is not to say that you should not aim for the best.

7.2.2 What Are the Results You Want to Communicate?

One of the first steps involved in writing a paper is to determine the scope of the paper and be convinced that you have a clear message to deliver and enough material to deliver it properly. Note that a research paper is for reporting a significant advance in knowledge; the editor of the journal will have to be convinced at the first glance of the paper that the information in the paper is significant, new, and worth publishing. The author should therefore evaluate the work objectively (which is not easy!) and be satisfied that the work being reported will make it through the journal's editorial scrutiny and review process.

7.2.3 A Plan for the Paper

Developing a paper from a proper plan and outline is always easier than making up the plan as you move along. A plan should contain something about everything in the paper: a working title, ideas of what should go into the Abstract, potential keywords, what the Introduction should contain, what details of Materials and Methods should be included in the paper and whether a separate posting of Supplementary Materials would be needed, what are the nature and contents of tables and figures, what are the major issues around which the Discussion should be

developed, how many literature citations would be included. The plan should also include such items as who should be enlisted to read and comment on the draft of the paper, who should be suggested to the journal as potential reviewers, when and who will write the individual sections, would copyright permissions be sought for anything included in the paper, what the target deadline would be for completing the task, and so on. Think through all these steps involved and procedures to be completed, such as approvals of funding agencies or institutional administrators, and anything else, and make notes on each of these steps. That will then help you develop an informal outline for the paper, which could be the framework on which to gradually build to complete the paper.

The approach will be easier once you are sure what should go into each section as well as which section would be better for certain ideas, say, in Introduction versus Discussion. Go through the whole paper like this, making lists of headings. That will enable you to identify things that have been left out or repeated, as well as determine whether certain subsections should be moved to different locations, etc. The requirements, instructions, and norms of the specific journal to which the paper is targeted should be taken into consideration for each of these issues.

Developing the plan for the whole paper can be done in bits and pieces depending on time availability. It is a good idea to take notes and scribbles of the ideas as each comes to you, because, for most people, ideas appear—and disappear—suddenly and it may be difficult to retrieve those flashes of ideas from your memory. This process is especially useful for the Discussion section, which always requires a lot of thought and interpretation. Along the same line of reasoning, References are another section that needs to be kept track of: as you come across an article of interest and relevance, note down its complete bibliographic details and store them in easily identifiable folders in your computer; looking for and retrieving such details later will be difficult and time-consuming (remember, however, that as mentioned in Sect. 2.11, the use of a reference building software is highly recommended).

7.2.4 The First Draft

Although there are no strict guidelines on the order in which different sections of a paper should be written, a working title should possibly be the first step. Most people use the title of their original research proposal or of the chapter of the PhD dissertation that forms the basis of the paper as the working title. Follow the guidelines given in Sect. 2.1 on what the title should and should not contain.

Making a start is one of the most difficult steps. Most experienced writers recommend beginning with the easiest section, Materials and Methods, which is a simple description of what you used and what you did, and then go on to the Results to describe exactly what happened. That will then take you to the most difficult section: Discussion. Some people, on the other hand, recommend starting with the most difficult section (Discussion) first so that everything else will then be easier.

Once you start writing a section, finish its first draft as soon as possible, when the flow of ideas about that section is clear in your mind. Initial focus should be on the scientific content and subject matter. "Fine-tuning" issues such as grammar, style, Latin names of plants, expanding telegraphic scripts and code words to full sentences, and polishing up the abbreviations according to the journal's instructions can be handled/addressed later. This (the first-draft stage) is also the time to assemble all the figures and tables and decide if all of them are really necessary.

7.2.5 The Second Draft

The first draft represents the first form of the "whole" paper assembled from the various constituent sections that had been prepared individually and pieced together. It may be far from complete and perfect, but it gives the appearance of how the final paper will look like. From this point forward, the whole paper is considered as one unit (rather than individual sections). The next step is to read through the document keeping the overall scientific content as the main concern.

As you move along, you will need to ask yourself various questions and make corrections and revisions accordingly:

- Does the overall paper meet your expectations?
- Is the order of presentation satisfactory?
- Does the paper contain all the ideas that were originally thought of?
- Are the paragraphs arranged in proper sequence to facilitate coherent flow of ideas?
- Are the paragraphs of the right size (neither too short nor too long)? Short paragraphs should be merged with the previous or the succeeding paragraph.
- Are parts of the paper adequately described?
- Are all parts of the text needed?
- Can any figures or tables be eliminated or combined?
- Is each piece of text in the correct section?
- Are all the headings and subheadings needed?
- Are all table and figure positions appropriately marked in the text?
- Is the literature citation up-to-date: is there any literature on the topic that appeared since you started writing that needs to be referenced in your paper?

Once all the changes listed above are incorporated, the resultant product can be called a third copy. Depending on the style of writing and extent of corrections, the paper may have to go through several iterations before it reaches this stage. Moreover, the terms second draft and third draft and so on are subjective; there are no hard-and-fast rules describing what constitutes a second draft or third draft; what one person calls a second draft may be what another one would consider as the first draft. The paper can be considered as a third draft when it is ready to be handed out to a colleague for reading.

7.2.6 The Third Draft

While the draft is being reviewed by a colleague or two, keep working on the paper to make sure that all "t's are crossed and i's are dotted." Check all the notes you had prepared while writing.

At this stage, you must check that all the references in your reference list are mentioned in the text and that the list contains only references cited in text (here, text includes tables and figures too; in other words, any reference listed in tables or figures should be in the List of References). As described in Chap. 2, there are several systems for citing and listing references. Make sure that you are following the style of the journal for which you are writing. Work through and check every page of your manuscript and every reference.

All tables and figures should be checked for style, consistency of headings and captions and formatting, as well as numbering. Make sure that all the tables and figures in the paper are mentioned in the text, and that all the tables and figures mentioned in the text are included in the paper. Check also that the figure number on the original figure corresponds with its legend and its citation in the text.

7.2.7 The Final Manuscript

This is the time to consider accepting or rejecting the comments and suggestions from the colleagues to whom you had given the draft for reading. The remarks that are considered suitable should be incorporated into the manuscript. Remember that it is your paper and it is entirely up to you to accept or reject any comments from colleagues.

The manuscript is now nearing its final form. Now is the time to ensure that *ALL* instructions of the journal on manuscript preparation such as style, lettering, units, nomenclature, reference citation, page numbering, line numbering, and so on, have been followed completely and consistently. You do not want the manuscript to be rejected or adversely commented upon for simple and avoidable mistakes. The attention of the journal editor and reviewers should not be allowed to be sidetracked and their opinions and judgments influenced by procedural mistakes; the only way of ensuring that is to eliminate such mistakes. In other words, it is the author's absolute responsibility to present the manuscript in a form and format such that it can be judged based solely on its scientific merit, not writing style.

An important thing to remember is that the manuscript, at every stage of its preparation, should be saved on multiple computers if possible and in more than one file.

7.3 Publication Ethics

Those who are outside the arena of science might consider science as a "perfect world" without the social issues such as code of conduct and ethics that are supposedly a part of the society at large. But, far from it: such problems are part of human behavior and therefore cannot be eliminated completely from anything involving humans. The impact of lapses in ethics and code of conduct, however, is most severe in science than in any other endeavor of human activity: politicians, business people, and even professionals such as lawyers and accountants can weather criticisms and storms of malpractices and other ethical failures; but a scientist once "convicted" of such malpractices has little to no future in science. Therefore, it behooves the aspiring early-career scientist to always observe strict code of integrity and ethics in the field of scientific publishing. The common ethical issues that scientists have to consider are discussed below.

7.3.1 Double Publishing

As the term indicates, double publishing refers to publishing the same paper in multiple journals or using the same set of data in multiple papers. All journals make it a condition that a paper submitted to that journal is not being considered for publication anywhere else. If a manuscript submitted to a journal is accepted for publication in that journal, the authors are ethically bound to publish it in that journal, and it should ***not*** be submitted to another journal for consideration unless and until it is released (rejected) by the first journal. Similarly, the same body of data contained in a manuscript under consideration of a journal should ***not*** be used to produce another manuscript for another journal. International journals are rather ruthless in dealing with dishonest authors.

Exceptions to these stipulations are available, however, for legitimate professional reasons. For example, several papers published on a topic in one or different journals, or as a special issue of a journal, may sometimes be put together as a "stand-alone" book, with the approval and explicit permission of all concerned (the authors as well as copyright holders of publications). Another situation is related to preparing a popular (general audience) publication incorporating some of the results reported in the scientific paper. The language of the popular article will be different from that of the scientific paper and its authorship may include those who are not authors of the scientific paper. These are not unethical practices. In fact, funding agencies encourage the publication of research results as popular articles for general audience. In all such cases, when sections or full text of a previously published article is included (not just cited) in another publication, a specific acknowledgment and full publication details of the original paper should be included.

The above also applies to translation of publications into other languages, and refining and publishing journal articles out of non-peer-reviewed conference proceedings. The important point is the spirit of ethics: the intent is not to restrict or prevent wide publication of research results, but to avoid unscrupulous practices.

7.3.2 Authorship

The general norms about authorship of papers have been presented in Sect. 2.2. In most cases these norms and procedures are followed. Ethical issues arise in a few cases where such norms are not followed. The common issues are related to who holds the right to the idea and data and what is the contribution of each claiming or entitled to authorship. As mentioned in Sect. 2.2, the general norm for papers originating from graduate students' research is that the student is listed as the first author and the major supervisor as the second authors (except in some disciplines where other norms are followed for listing the authors).

An ethical lapse of a different nature related to authorship is listing somebody as an author without the approval of that person. Often, the motivations for resorting to such an objectionable practice is the author's perception that listing a reputed senior colleague as an author might facilitate "easy" passage through the peer-review process and expeditious publication of the paper. To avoid such situations, most journals nowadays require the approval of all authors listed on the manuscript before it is taken up for consideration.

7.3.3 Plagiarism

Dictionaries define plagiarism as some kind of literary theft or stealing of intellectual property; but the definitions are somewhat fuzzy. "If you take a substantial number of words or the bulk of an idea that had been written by someone else and publish them in your own paper without attribution to the original author, it is plagiarism by anyone's definition" (Luellen 2001). As Wikipedia describes, "Within academia, plagiarism by students, professors, or researchers is considered academic dishonesty or academic fraud, and offenders are subject to academic censure, up to and including expulsion." Direct quotation or word-for-word transcription, unacknowledged quotation, paraphrasing and/or use of ideas are all cited as examples of plagiarism. Double publishing one's own work as described above also is a form of plagiarism.

Plagiarism is not the same as copyright infringement (see next section), but both constitute academic dishonesty. Plagiarism can sometimes result from ignorance in how to reference other works. But ignorance is no excuse. The best course of

action is to learn and adopt the accepted conventions for documenting and referencing works of others, which is an experience that a writer accrues over time, and obtain copyright permission wherever needed.

7.3.4 Copyright

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

Copyright is a legal concept by which the creator of an original is given the exclusive rights to it. Although it means the "right to copy," it gives the copyright holder the right to be credited for the work and to determine other related rights such as who may adapt the work to other forms and benefit from it financially. Strict copyright and intellectual property laws and statutes exist in most countries such that violators could be penalized.

In academia, if a written work is to be published, the authors will usually transfer some or all of these rights, by formal agreement, to the publisher. When an article is accepted by a journal, the author is usually asked to sign a formal transfer of rights to the publisher. The publisher will then hold the copyright. Most journals will publish a copyright notice where they claim the copyright, as indicated by the symbol, ©, sometimes the word 'copyright', and the year of publication and the name of the copyright holder; sometimes the phrase "all rights reserved" also appears.

If you wish to include a figure or a table or any other part of a copyrighted material in a new publication, even if it is from your own previous publication, you must get permission from the copyright holder. It is not a difficult procedure; all it takes is for you (the author) to write to the publisher giving details of the relevant section that you wish to reproduce and where you plan to publish it. Most publishers approve the request at no charge and inform you how the credit line should appear. You will be required to send the permission to the journal or publisher along with the manuscript or at a later stage before the manuscript is finally taken up for printing. It is a common courtesy to inform the principal author of the article in question about your desire to reproduce that author's work. Most journals recommend standard copyright-request forms to be used. When such a copyrighted material is included in your paper, its original source should be acknowledged, which is usually done by adding "reproduced with permission from (journal name and publication details)."

Summary Points on "Preparing the Manuscript"

- The research project is not complete until its results are written up as scientific papers and submitted for publication in appropriate journals
- Writing and publishing a paper takes more time than originally estimated
- Unanimous views or definite instructions are not available on when and in what order the different sections of a paper should be written
- Develop a plan for the paper and start assembling its essential parts as the research progresses. If different authors are writing different sections, develop a schedule of who does what and when, and follow that schedule
- Overcome the "fear complex" that most early career scientists have
- Be clear about the scope of the paper and the message you want to deliver
- Consider the requirements and norms of the journal to which you wish to submit the paper
- Some experienced authors recommend that easiest sections should be completed first
- Prepare a first draft by piecing together the various sections following the target journal's instruction to authors
- Read through the first draft, make corrections, and develop a second draft, then a third draft, and so on
- When you are confident that the draft paper has reached a satisfactory stage, give it for reading to some trusted colleagues
- Incorporate the suggestions and address the comments of the colleagues as deemed appropriate, and develop the final draft
- At every stage of preparation of the paper, observe the strict code of ethics related to double publishing, authorship, plagiarism, copyright permission, etc.

Chapter 8
Dealing with the Journal

Abstract The most widely accepted criterion for journal quality is its Impact Factor (IF); the higher the value the better the rating. Nowadays all journals require that the manuscripts be uploaded online following the menu-driven instructions. All journals follow the "blind" peer-review procedure for getting an objective assessment of the scientific quality of the paper. Points on which the authors disagree with the reviewers and the reasons for that should be brought to the editor's attention. Once the manuscript is accepted for publication, the author will have a chance to do the final scrutiny of the pre-publication proof. If an article is not accepted by a journal but has not been detected to have any "fatal" flaws such as faulty experimental procedures, the authors may pursue the option for publishing it in another journal.

8.1 Selecting a Journal

Several factors have to be considered in the choice of a journal to which you would like to submit your paper. Every scientist would probably want to publish in top-notch science journals that publish articles in all branches of science (e.g., *Science*, *Nature*) or at least in top journals in the discipline. Although it is a good ambition, you may have to scale down the expectations based on the reality and choose a journal that publishes papers related to your subject, at the level of scientific content of your paper, for your target audience. The names of most thematic journals explicitly announce their focus themes; for example, *Agricultural Economics, Agroforestry Systems*, *Agronomy Journal*, *Crop Science*, *Soil Science*, *Forest Science*, *Journal of Environmental Quality*, *Journal of Environmental Management*, *Plant Physiology*, and so on. A casual Internet search will show the large number of journals that are available. Added to that, there has lately been a proliferation of online journals such that, compared to two or three decades ago, today there is a

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_8,

wide array of journals from which to choose even for a specialized branch or discipline.

Choosing a journal is somewhat similar to choosing an institution for higher education. Publishing in high-quality journals earns more recognition, prestige, and career advancement opportunities—just like getting educated in top-notch universities. For that reason, authors would like very much to publish in the best journals. But, because of the high number of authors seeking to publish in high-ranking journals, it is difficult to get published in such journals; in general, the higher the rating of a journal (see the following section), the more difficult it is to get a paper accepted in that journal.

8.1.1 Journal Quality: Impact Factor

Several criteria exist for comparing journal quality. The most widely accepted one is the Thomson Reuters "Impact Factor" (IF). It was devised by Eugene Garfield, the founder of the Institute for Scientific Information (ISI), which later became Thomson Reuters. The values determining IF are calculated yearly starting from 1975 for those journals that are indexed by "Web of Knowledge" (a vast citation database), which indexes more than 11,000 journals in science, including social sciences.

Currently, IF is considered to be a benchmark of a journal's value as it recognizes how frequently peer-reviewed journals are cited by other researchers in a particular year. For a given year, the IF of a journal is the average number of citations per paper published in the journal during the preceding two years. For example, if a journal has an impact factor of 3 in 2012, then its papers published in 2010 and 2011 received three citations each on average in 2012. Thus, the 2012 IF of a journal would be calculated as follows:

- A The number of times articles published in that journal in 2010 and 2011 were cited by articles in indexed journals during 2012
- B The total number of "citable items" published by that journal in 2010 and 2011. ("Citable items" are usually articles, reviews, proceedings, or notes; not editorials or letters to the editor.)

$$\text{Impact Factor 2012} = A/B.$$

Note that the 2012 IF are actually published in 2013; they cannot be calculated until all of the 2012 publications have been processed by the indexing agency. New journals will therefore not get an IF until after having been indexed for three years.

Several criticisms have been made about the validity of IF as a measure of importance of the journal; an important one is that IF is dependent on the academic

discipline. Research papers in a discipline that has a large number of scientists working in it around the world may get high citation numbers, and therefore journals that publish such articles get higher IF ratings. Similarly, journals that publish articles from all branches of science, compared with specialized journals with relatively narrow and limited readership, get higher IF values. For example, top-notch journals such as *Science* and *Nature* that publish articles from all branches and disciplines have IF values higher than 20, whereas international specialized journals in agriculture and natural resources that are top-notch in the respective disciplines have IF values less than 5. In spite of these criticisms, IF is considered an important criterion of journal quality and ranking today, and each discipline has general norms for journal rating.

Publications in non-IF rated journals are sometimes not considered as important scientific publications and most high-ranking journals do not accept such papers as valid references. Other criteria and indexes of less general nature are also available for comparing journals; those details are beyond the scope of this book, but could be obtained from the Internet or other sources. Some countries have developed their own national standards of IF for evaluating journals published in the country that are not covered under the Thomson Reuters system.

8.1.2 International Versus Local Journals

Many leading developing countries, especially the large ones such as India and Brazil, have several professional organizations and scientific journals. For example, there is an "Indian journal of xxxx" in almost any specialized discipline of agriculture and natural resources. Some of them have been in existence for several decades now and have published and continue to publish enormously valuable research. Unfortunately, however, many of them are not included in the Thomson Reuters *Science Citation Index*and are therefore not covered by their Impact Factor system. This obviously results in pressure on scientists to publish in "international" journals with IF. The quality of the journals in which scientists publish their work is an important consideration in career evaluations in many national systems, and a distinction is sometimes made in those countries between "international" and "local" journals. The implication of the label "international" is—ought to be—a reflection of whether the journal is indexed for IF, although other "convenient" interpretations might be devised and used.

The subsequent sections of this chapter are prepared with focus on journals that are indexed for Thomson Reuters Impact Factor.

8.2 Submitting the Manuscript

8.2.1 Manuscript Preparation

The first step in manuscript preparation is to read thoroughly the journal's Instructions to Authors (which may be known by different names: Guidelines, Directives, etc.). These can be found in the journal's website and are usually published on the final pages of the last issue (or, the first pages of the first issue) of each volume of the journal. Manuscript submission and follow-up will be easy if the instructions are followed properly and accurately. Those who do not follow the instructions may encounter problems and delay in getting their work published. Instructions on "how to" will be provided on a whole host of issues discussed in the previous sections of this book: designing a proper title, selecting the appropriate font size, numbering the paragraphs, tables and figures, listing the authors and their institutional affiliations, preparing the abstract and keywords, constructing the tables and figures, organizing the manuscript, formatting the text, providing page numbers and line numbers, structuring reference citations, obtaining copyright permission, and many more. Some of these are quite easy, but some, such as formatting the references according to the journal's style, could be time-consuming. Most journals will require different sections of the manuscript such as title page and abstract, main text, tables and figures, and so on, to be saved as separate files for electronic submission.

8.2.2 Manuscript Submission

Nowadays, almost all journals require the manuscripts to be submitted electronically. The step-wise procedure and sources of help are explained on the journal's website. The first step in the process is to log-in to the journal's website and register as an author interested in submitting a new manuscript. You will then be prompted to follow a step-wise procedure, which has become a somewhat standard one for most journals. A formal letter forwarding the manuscript for consideration is no longer required by journals, but could still be submitted. During the manuscript uploading (submission) process, authors will be given the chance to upload any additional special message to be conveyed to the editor/journal as well as copyright clearances and other relevant documents. Most journals also require that the authors provide a list of potential reviewers for the manuscript along with their electronic contact details. The submission (uploading) process need not be completed in one sitting. The author has the option to pause and get back to the site. But remember to save whatever has been uploaded; the website, if left inactive, may shut off automatically after a certain length of time (usually only a few minutes), and any data not saved will be lost. A pdf of the submitted manuscript will be created during the submission process and presented to the author for

approval. Approval of that pdf by the author will signify the final stage of successful submission of the manuscript. Once all steps in the menu-driven procedure are satisfactorily completed, the author will be notified accordingly and a manuscript number for future reference provided.

The authors also have the option to submit the manuscript manually when electronic submission is not feasible. That will involve the "old" procedure of sending usually two hard copies of all text and possibly an electronic file (CD) of the manuscript to be submitted via dependable mail. Again, instructions are provided by the journal. This practice of manual submission, however, is seldom followed these days.

8.3 Peer Review of the Manuscript

Peer review is the process by which the journal editor seeks the advice and suggestions of other experts ("peers") to get an objective and skilled critique of the merit of the paper being considered for publication. Journals have used this procedure since the first "scientific" journals began publication in the 17th century. This process allows editors to screen the paper for any flaws and select the best papers for publication; moreover, the reviewers usually offer constructive suggestions to improve the quality of the paper.

Peer reviews are designed to get objective assessment of the paper (Bornmann 2013; Foley 2013). Personal biases are avoided by following the "blinded" review, by which a reviewer or/and an author remain anonymous to each other ("single" blinded when the authors are anonymous; "double" blinded when both authors and reviewers are anonymous). The blinded review procedure, however, may not always be effective in maintaining the anonymity of reviewers and the effectiveness of the process. As mentioned in the previous section, the authors are nowadays required to submit along with the manuscript a list of potential reviewers (from which the editor may select some). Furthermore, the authors may be able to identify the reviewer through the nature of their comments, especially so in narrow fields of specialty where "everybody knows everybody else." Even in a double-blinded system, an expert reviewer may be able to identify the author through self-citations and references to earlier works. Some other issues mentioned as contributing to reduction in the effectiveness and objectivity of peer review include conflict of interests when reviewers may wish to delay or suppress certain work being published, lack of availability of expert reviewers especially in the context of increasing numbers of journals, and ignorance of reviewers leading to failure to bring out errors and flaws.

Despite these shortcomings, peer reviews are adopted by almost all journals. In addition, journals are also adopting new techniques such as asking the reviewers to rank the manuscripts in terms of their acceptability according to a quantitative scoring system. There is still no clear consensus of expert opinion whether and to

what extent any of these methods actually improve the assessment of scientific quality. As far as the authors are concerned, the expedient thing is to follow the journal's instructions and abide by their rules and procedures.

8.4 Communications from the Journal

8.4.1 Initial Screening Before Peer Review

When a manuscript is successfully submitted online, the author will instantaneously get an acknowledgment to that effect from the journal. Usually, the editor will take a "quick look" at the manuscript and determine if it meets the journal's criteria for taking it up for peer review. If a manuscript is found not acceptable in the editor's first screening (see Sect. 8.5 for potential reasons for such a decision), the author will be notified immediately. If such a "rejection at first screening" notification is not received within a couple of weeks of submitting the manuscript, it is an indication that the manuscript has been taken up for peer-review. Most journals, however, avoid the suspense by informing the author if the manuscript has been taken up for peer-review. If a paper is rejected by a journal, the author is free to pursue publication options with other journals (see Sect. 8.5). But, if a paper is under consideration of a journal, the author is ethically bound to not pursue other publication options until the final decision is communicated by the journal. That decision may take several weeks or even months depending on the journal.

The delay in deciding on the acceptance of a paper by a journal is caused mostly by the peer-review process, specifically the reviewers. Reviewers are not rewarded financially for the time spent on reviewing manuscripts, yet they accept the invitation to review because of their professional interest and obligation. Being expert professionals, however, their time is in high demand and usually overcommitted such that, in spite of their good intentions, their reviews get delayed. It is quite common that reviewers who originally agree to review the manuscript get overwhelmed to the extent of not being able to complete the review in a timely manner, and the editor will then have to seek the help of another reviewer, causing more delay in the peer-review process. Another possible reason for the delay is the conflicting recommendations by reviewers. If a manuscript is recommended to be rejected by one reviewer and accepted by another, the editor will be in a quandary and may seek the opinion of a third or even fourth reviewer. Thus, in spite of the best efforts by journals, delay in peer review is of common occurrence. If the author does not receive a satisfactory response from the journal about completion of peer-review within a reasonable time period after submitting the manuscript, the author may send a notice of withdrawal to the journal and pursue publication options with another journal.

8.4.2 Response to Peer-review Decision

The communication received from the journal's editor will usually include each reviewer's comments and suggestions and the editor's decision in light of the review comments. The decision will usually fall into one of the following categories:

- Accept the manuscript with very little or no modification
- Accept with some changes ("minor revision")
- Accept after substantial modification ("major revision")
- Reject

Except when a manuscript is rejected, the time limit within which the final manuscripts should be returned after revision will be specified in the communication from the journal. If additional time is needed to complete the revision (especially for major revision), that request should be submitted as soon as the review decision is received. Most journals stipulate that "If the manuscript is not returned by the specified time, then a revised manuscript is usually considered as a new submission and will have to undergo the entire review process again."

Many authors, especially less experienced ones, may consider that the review comments and the subsequent decision by the editor are irrevocable. That is not the case. Reviewers are your professional colleagues, and treat them so: with professional courtesy and respect, but not necessarily fully agreeing with their opinions. Consider also that the reviewers might have reached a wrong judgment based on any number of reasons: not understanding the authors' interpretation of results, lack of familiarity with the latest techniques and procedures in the subject, philosophical objection to the authors' line of argument, and so on. If the authors have valid reasons to dispute a reviewer's comments, they should bring the matter to the editor's attention and ask for a reconsideration of the decision. If both sides (the reviewer and the author) do not relent, the editor may make a final decision with or without seeking the advice of another reviewer. Such cases, however, are very rare. A point to remember, though, is that the authors are required to address the reviewers' comments, not necessarily accept them. Any justification for not agreeing with the reviewers' comments should be listed separately and specifically and submitted to the editor.

Only very few manuscripts (usually not exceeding 5 % of the total manuscripts accepted by a journal) are accepted with practically no change. Articles returned to authors for minor revision represent good articles in terms of their content and style (writing and presentation). If the author agrees with the suggested minor revision, it can be completed and the final manuscript returned to the journal in a relatively short span of time. When major revisions are requested, the time taken to complete them will depend, naturally, on the nature of revision. Some suggestions are doable; for example, reanalyzing the data according to a different procedure, re-interpreting the data in light of any new information that might have become available since submission of the manuscript, and so on. On the other hand, there might be situations where the requested revisions are just not possible to be

undertaken; for example, a demand for more laboratory analyses of the samples that had been used during the original investigation can be fulfilled only if those samples are still available. Some review comments could be of a very general nature; for example, "the writing needs considerable improvement in English and style." The authors of this book have experienced several cases where the manuscript authors take such comments as personal affront and get back to the editor with irate retorts that they had been studying and writing English since their childhood and so on. What such authors do not recognize, however, is that doing something for a long period does not necessarily mean that they have been doing the right thing. They should, in such cases, overcome their emotions and try to get the manuscript scrutinized by a person with competence in the given issue. Such efforts may sometimes be infeasible. Hopefully, this book (and similar other books) will be of some help in such situations.

8.5 When a Paper is Not Accepted

The authors will, naturally, be disappointed when a manuscript is not accepted (in other words, is rejected) by a journal. When it happens, the first thing to do is to let the situation "cool off" for a while. Leave the thought about the manuscript aside for a few days. After you have regained your capacity for coherent and balanced thinking, go back and read through the editor's and reviewers' comments. Try to discern reason from rote, and understand the logical and scientific reasons based on which the manuscript was rejected.

8.5.1 Reasons for Rejecting a Manuscript

A paper could be rejected for a number of reasons:

Lack of relevance to the journal: The subject matter is not relevant to the scope of the journal. Such a decision is usually made by the editor at the outset (before peer review). Sometimes, however, an editor who feels that a paper is a borderline case in terms of its relevance to the scope of the journal may give the benefit of doubt to the authors and ask for the reviewers' opinion. If the reviewers, too, recommend that the paper is outside the scope of the journal, the editor may have little choice but to reject that paper. If a paper is rejected for the reason that its subject matter is outside the scope of the journal, the authors should gracefully accept the responsibility for the mistake of sending it to the wrong journal (see Sect. 8.1).

Proliferation of articles of a similar nature or same topic: There could be too many worthwhile articles of acceptable quality on same or similar lines of investigation. In this case the editor might decide not to overload the journal with

articles on the same or similar topic. This could happen when there is a new wave of enthusiasm on a certain "hot" topic of investigation (e.g., climate change and carbon sequestration during the past decade) such that many scientists would be attracted to that line of research, resulting in a proliferation of papers of a somewhat similar nature.

Delay in publishing the results: As described in Sect. 7.2, delay in publishing the results in a timely manner could lead to rejection of the manuscript. Journals are not interested in publishing obsolete results, and rightly so.

Other reasons: Flaws in experimental design (such as lack of replication and randomization, or faulty assumptions), measurements, and data collection and analysis can inflict fatal blows to aspirations and opportunities for publishing such work.

8.5.2 What to do with a Rejected Paper?

Rejection of a paper by a journal, however, need not mean that the author should abandon the hope for publishing that paper, except in situations where the research is flawed. An option that most authors adopt is to submit the manuscript rejected by a journal to another journal after appropriate modifications.

- If the rejection is based on the reason that the paper is outside the scope of the journal to which it was first submitted, it is a logical course of action to submit it to a (more) relevant journal
- If the reason for rejection is paucity of data or insufficient analysis or such other technical reasons, the deficiencies could be rectified by gathering more data, undertaking more detailed and appropriate analyses, providing additional interpretation of results, and so on. Usually reviewers' comments will direct the researchers in choosing the appropriate course of action
- If the authors are convinced that the reviewers' lack of proper understanding of the authors' viewpoints is the reason for rejecting the paper, the authors could offer more detailed and convincing explanations. In such situations, the authors should seek the editor's suggestions and advice on the best way to proceed
- Improving the paper following the reviewers' comments on the earlier version will greatly enhance the probability for acceptance at the second attempt
- Authors are strongly advised not to pursue alternate publication of a paper rejected for fatal flaws because that could ruin their career reputation. Relatively narrow fields of specialization consist of a rather small circle of scientists who often know each other. As such, the publication record (and attempts) of a scientist has an important bearing on his/her professional and career reputation; "short-cuts" to instant fame through unscrupulous means will backfire and ruin the scientific credibility of the individual.

8.6 Proof Correction

A few days or weeks after receiving the journal's notification about acceptance of a paper, the designated author for correspondence will receive electronic notifications about impending publication of the paper and various actions expected of the author to facilitate the process. These include signing a series of forms to ensure that mandatory requirements about declarations pertaining to funding agency, copyright, etc., have been fulfilled, the contact information provided is correct, and the order form for purchasing additional reprints if needed has been completed. All these need to be returned to the journal office after scrutiny and approval, which can be handled electronically. Soon after that the proof will arrive via email to the corresponding author.

8.6.1 Proofs

A proof is the preliminary version of the publication meant for review by the author and the only chance given to the author to make any further modification to the paper. When proofs are hand-set, the printer would set the page into galleys or metal trays into which type is laid and tightened into place, and proofs produced out of the galleys are called **galley proofs**. These would be used to print a limited number of copies for editing mark-up, a copy or two of which would then be sent to the authors for proofreading, with *Galley Proof* printed across the pages in large, faint font. Nowadays, galley proofs are replaced by **page proofs** that are prepared by transferring the data directly from electronic files in a near-final version for editing and checking purposes. They will be marked *Uncorrected Page Proofs* across the pages in large but light fonts (similar to that for Galley Proofs) and sent to the authors electronically for proofreading. Uncorrected proof describes the penultimate proof version (on paper or in digital form) yet to receive final author and publisher approval. Upon receiving the corrected proof from the author, the publisher will incorporate the corrections and edits and print the final copy.

8.6.2 Proofreading

Proofreading (one word, unhyphenated) refers to the reading of a proof (galley or page) to detect and correct errors. Compared with the galley proofs, page proofs are usually true to the original manuscript since they are transferred electronically; moreover, the material is copy-edited and the page layouts examined closely by the publisher before making the proof such that mistakes are usually very few. Correcting mistakes at this stage is expensive. Authors are discouraged from making changes to page proofs; the journal may charge the author for any substantive changes to the proof consequent to modifications to the material provided in the original manuscript.

Copyediting is a term that some people confuse with proofreading. Copy editing (also written as two words or a hyphenated word: copy-editing, copyediting) is the work that an editor (copyeditor, known as subeditor in the U.K.) does to improve the formatting and accuracy of text without altering its substance, and it is done before typesetting and proofreading. Copyediting involves correcting spelling, punctuation, grammar, terminology, jargon, and semantics (Chap. 6) according to the publisher's style.

Author proofs are sent to the corresponding author via email as a pdf file that is usually not editable. Instructions for correcting the pdf are also sent along with the proof. The pdf can be either printed out and the corrections marked on it and returned to the journal editorial office or corrections can be marked on the pdf by following the instructions. Standard proof-correction marks must be used for proof correction. These marks and instructions are usually sent to the author along with the uncorrected proof, or can be accessed/downloaded from any one of the numerous websites available. The common marks of proof correction are illustrated in Table 8.1 and proof reading abbreviations indicated in Table 8.2.

Check the tables and figures for accuracy of data, formatting of column subheadings, labeling of figures and axes of graphs, etc. Also, ensure that the figures and tables are embedded in the appropriate places in the proof. Although the authors will have followed the instructions and indicated the approximate location of the table and figure in the original manuscript, the typesetters may place them differently depending on restraints of the page configuration. Sometimes this leads to the placement of the table or figure before it is actually referenced in the text. Such errors should be brought to the attention of the typesetter/editor.

Corrections made on the proof must be very clear to the typesetter. If there is not enough space for making all the corrections on the margin, indicate these on a separate sheet of paper with clear referencing to page number and line number indicating the correct position. Do not enter the corrections in between lines of text because such corrections will be hard to read and unclear. Do not use capital letters to write the corrections unless the material should appear in capitals. In exceptional cases, when a page becomes too crowded with corrections, especially with mathematical equations or chemical formulas, and the author has serious concerns if the corrections would be clear to the typesetter, the author may ask for a new proof for a specific section or the entire paper even if that might cause some delay in publication of the paper.

The corrected proof must be returned within the specified deadline, and it can be done electronically. A few days after receiving the final corrected proof, the journal will publish the paper online with a DOI (digital object identification) number. The paper can then be accessed, and cited as published, with that DOI number. In journals with print versions of issues, the papers that are published online will be included in one of the subsequent issues of the journal. The paper is usually cited with the DOI number until the print version appears; thereafter it is cited with the year and relevant volume and page numbers of the issue in which the article is printed.

Table 8.1 Common proofreading symbols

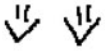
Symbol	Meaning	Example
	insert a comma	The mayor's brother, I tell you, is a crook.
	apostrophe or single quotation mark	I wouldnt know where to put this vase.
	insert something	I know it in fact, everyone knows it.
	use double quotation marks	My favorite poem is Design.
	use a period here	This is a declarative sentence
	delete	The elephant's trunk is is really its nose.
	transpose elements	He only picked the one he likes.
	close up this space	Jordan lost his favorite basket ball.
	a space needed here	I have only threefriends: Ted, Raoul, and Alice.
	begin new paragraph	"I knew it," I said. "I thought so," she replied.
	no paragraph	"I knew it, she said. No ¶ "He's no good."

Table 8.2 Proof reading abbreviations

Abbreviation	Meaning	Example
Ab	A faulty abbreviation	She had earned a Ph.D. along with her M.D.
Agr	Agreement problem: subject/verb *or* pronoun/antecedent	The piano as well as the guitar need tuning
See also P/A and S/V		The student lost their book
Awk	Awkward expression or construction	The storm had the effect of causing millions of dollars in damage
Cap	Faulty capitalization	We spent the Fall in Southern Spain
CS	Comma splice	Raoul tried his best, this time that wasn't good enough
DICT	Faulty diction	Due to the fact that we were wondering as to whether it would rain, we stayed home
Dgl	Dangling construction	Working harder than ever, this job proved to be too much for him to handle
-ed	Problem with final *-ed*	Last summer he walk all the way to Birmingham
Frag	Fragment	Depending on the amount of snow we get this winter and whether the towns buy new trucks
| |	Problem in parallel form	My income is bigger than my wife
P/A	Pronoun/Antecedent agreement	A student in accounting would be wise to see their advisor this month
Pron	Problem with pronoun	My aunt and my mother have wrecked her car The committee has lost their chance to change things You'll have to do this on one's own time
Rep	Unnecessary repetition	The car was blue in color
R-O	Run-on sentence	Raoul tried his best this time that wasn't good enough
Sp	Spelling error	This sentence is flawde with two misspellings
-s	Problem with final *-s*	He wonder what these teacher think of him
STET	Let it stand	The proofreader uses this Latin term to indicate that proofreading marks calling for a change should be ignored and the text as originally written should be "let stand."
S/V	Subject/Verb agreement	The problem with these cities are leadership
T	Verb tense problem	He comes into the room, and he pulled his gun
Wdy	Wordy	Seldom have we perused a document so verbose, so ostentatious in phrasing, so burdened with too many words
WW	Wrong word	What affect did the movie have on Sheila? She tried to hard to analyze its conclusion

The abbreviation would appear in the margin, probably with a line or arrow pointing to the offending element

Source http://webster.commnet.edu/writing/symbols.htm

If any major mistakes (such as data errors or omissions) are noted in the paper after it is published, that should be brought to the attention of the journal's editor and publisher as soon as possible. They will then work with the author and publish a note called "Erratum" in a subsequent issue of the journal.

After the paper/journal is published, the author for correspondence might be contacted by interested readers for various reasons related to the paper, such as request for reprint, clarifications and additional information on methodologies, advice and opinions on ongoing research of a similar nature, and so on. Thus the authors become members of the scientific community, get recognized for their work, and are entitled to all the professional benefits appertaining thereto.

Dealing with the Journal

- Choice of the journal depends primarily on the subject matter and the journal's quality
- The most widely accepted criterion for journal quality is its Impact Factor (IF); the higher the value the better the rating
- The international journals in agriculture and natural resources have IF values of less than 5
- Prepare the manuscript strictly according to the journal's instructions to authors
- Nowadays all journals require that the manuscripts be uploaded online following the menu-driven uploading instructions
- All journals follow the "blind" peer-review procedure for getting objective assessment of the scientific quality of the paper
- The journal editor will forward the peer-review comments on the articles to the authors with advice on if the paper is acceptable
- Papers that are acceptable may have to be revised based on the reviewers' and editor's comments and suggestions
- The authors will then revise the manuscript and address the reviewers' and editors comments
- Points on which the authors disagree with the reviewers and the reasons for that should be brought to the editor's attention
- If the revised version is satisfactory to the editor, it will be accepted for publication
- A pre-publication proof (page proof or galley proof) of the article will then be sent to the author for careful scrutiny
- Upon submission of the corrected proof and all the required forms, the paper will be published, first online with a DOI number and subsequently in the print version of the journal
- If an article is not accepted by a journal but has not been detected to have any "fatal" flaws such as faulty experimental procedures, the authors may pursue the option for publishing it in another journal

Part IV
Oral and Poster Presentations

Chapter 9
Oral Presentations

Abstract While scientific writing provides an opportunity for disseminating the knowledge gained in research findings to others, another means of communicating new research results is through oral and poster presentations at meetings and conferences. This is the most likely form of scientific communication among peers, especially for early results. Oral presentations use a more conversational style than in a written communication to convey the research results to others in the field. The authors can use the oral presentations to clarify doubts and explain the points that may not be clear in writing.

As noted earlier in this book (Sect. 1.1.2), science is all about the pursuit of knowledge. Scientific writing provides an opportunity for disseminating the knowledge gained in research findings to others. Another means of communicating new research results is through oral and poster presentations at meetings and conferences. This is the most likely form of scientific communication among peers, especially for early results. Such presentations are also used for reporting to funding agencies and business colleagues or general public. This chapter deals with oral presentations; the next chapter (Chap. 10) deals with poster presentations.

9.1 "To Do" Prior to Preparing an Oral Presentation

9.1.1 Identify the Audience

It is important to identify your audience prior to preparing an oral presentation. The same information can—and will need to—be presented in different ways depending on the audience. The presentation will have to be prepared in consideration of the nature and expertise-level of the audience you are addressing so that they can be

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_9,

effectively engaged. If you are making the presentation to a strictly scientific gathering such as a professional society meeting or a seminar at a university/research institution, the purpose of the presentation is to inform the group of your new research findings and to seek their input. On the other hand, if the intent is to disseminate information from your research to farmers or an extension-related audience, it is important to demonstrate how your findings can be used for practical purposes. Funding agencies would like to know if and how the funds allocated were used effectively; therefore it would be important in your presentation to emphasize how your project objectives were addressed. Presentations to a business-related audience would likely involve an emphasis on the financial impact of your research findings. The focus of this chapter is on oral presentations at meetings or conferences for communicating research results to those working in similar fields.

9.1.2 Determine the Nature and Time Allowed for the Presentation

Presentations at meetings and conferences could be to either a symposium or one of the conference sessions. Speakers at symposia are usually identified in advance by symposium organizers and invited to make the presentation on a previously discussed subset or topic related to the main theme of the symposium, whereas presentations at technical sessions are selected by the session organizers out of participants who volunteer to make the presentation on their current research related to the theme of the session. A keynote presentation is the opening lecture at a symposium, delivered by a leading professional in the topic who has been identified in advance and specially invited for the purpose. Such presentations are supposed to provide an authoritative overview of the state-of-the-art of the subject, identify future lines of research, and set the tone for the ensuing discussions in the conference/meeting. Time allocated for different types of oral presentation will be set by the conference organizers and communicated to the presenters in advance. Presentations by early-career professionals including graduate students mostly fall under the category of voluntary presentations, for which the time allocated at most professional conferences is 15–20 min.

9.2 Preparing Your Oral Presentation

A draft of the oral presentation is a good starting point. In a 15 min presentation, the talk should be limited to about 12 min, leaving about 3 min for discussion (question–answer) with the audience. Most scientific presentations these days use Microsoft PowerPoint slides. The number of slides to be used will have to be carefully selected considering the information you would like to present within the allocated time. “One slide per minute” is the general rule of thumb. Therefore, in an effective presentation, the number of substantive slides, i.e., slides that need

explanation, should be tried to be limited to 12; do not exceed 16 including all the "peripheral" slides that may need only little explanation.

The distribution of topics in a 15 min presentation should be determined carefully depending on what you intend to achieve. For a student, particularly those who are participating in a competition, the contents should be similar in format to that of a journal manuscript: Introduction, Objectives and Hypothesis, Materials and Methods, Results and Discussion, followed by Conclusions. The presentation is often judged with marks allotted to each of the categories. Often, the organizers provide the presenter with the guidelines for judging the presentations; an example is shown in Appendix 9.1.

The format of the presentation will depend on its scope and objective. If the objective is to present the results of a scientific study, it is advisable to follow the IMRAD format (Chap. 2). If the objective is to present a synthesis of the latest knowledge on a topic, or a major research proposal, or introduce a new instrument or method, or anything else, the format of presentation will have to be determined individually for each purpose. This will enable you to make the best use of the allocated time and most effectively put across your ideas and intentions on the topic. All presentations require an introduction and some lines of conclusions. Everything in between will be specific to each presentation. The presenter needs to find innovative ways to effectively communicate the message to the audience.

9.2.1 Title and Introduction

Title slide: The title of the presentation follows all the general rules and norms for scientific papers explained in Chap. 2. The title should be short but at the same time provide a clear indication of the contents of your talk. The author, co-author(s) if any, and their affiliations should be indicated next. It is also appropriate to include logos of the appropriate institutions. Figure 9.1 is an example of a title slide. Some additional details that are applicable to both oral and poster presentations are discussed in the chapter on Poster Presentation (Chap. 10).

Introduction slide(s): Begin your talk with an introduction to your topic (Fig. 9.2). State the purpose of your talk (hypothesis and objectives, Fig. 9.3); an outline of your entire presentation will help the audience follow through your presentation more easily.

9.2.2 The Main Body of Your Presentation

The next few slides follow the outline presented in the Introduction. Present your ideas logically, with a smooth flow from one slide to the next. This section of the presentation gives you an opportunity to use your communication skills to enhance

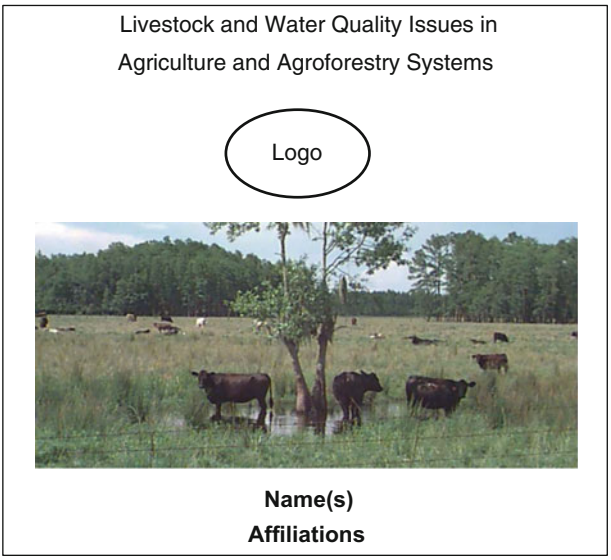
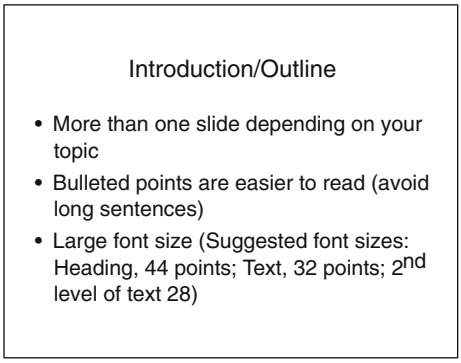


Fig. 9.1 Example of a title slide. Photo credit: Soil and Water Science Department, University of Florida

Fig. 9.2 Example of an Introduction/Outline slide



the audience's interest in your subject; the number of slides to be devoted for this will depend on the topic of presentation and the expected level of comprehension of the audience.

- After the Introduction slide, you may want to present one or more slides for the Materials and Methods (Figs. 9.4, 9.5)
- The slides for Results will contain appropriate tables (Figs. 9.6, 9.7)
- Make sure that the tables and graphs are easily understandable and that they contain just the optimum amount of information—neither too little nor too much

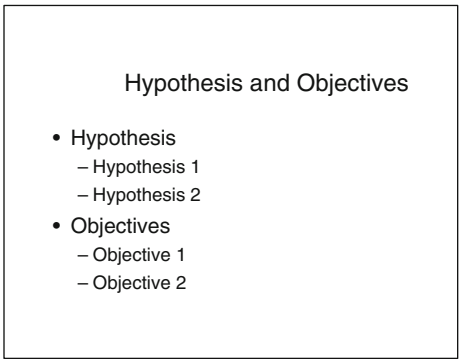


Fig. 9.3 Example of a Hypothesis and Objectives slide

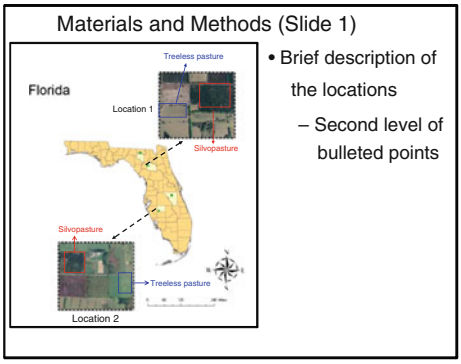


Fig. 9.4 Examples of slides for Materials and Methods (1). Figure modified from Haile et al. (2008)

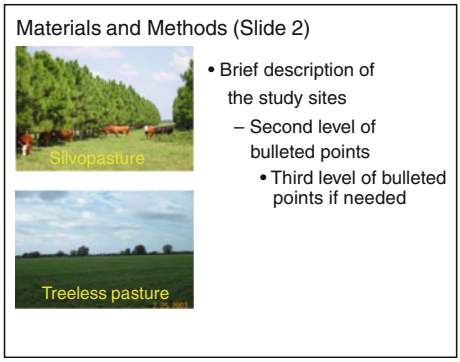


Fig. 9.5 Examples of slides for Materials and Methods (2)

- Use informative headings for each slide: tables (should) have headings and figures (should) have captions as discussed in Chap. 3
- Indicate, if appropriate, the statistical relevance of data
- Use of colors for rows or columns often helps to make your presentation easier to understand; however the colors should be used carefully to give a pleasing appearance. A mismatch of too many bright colors should be avoided

Results: Example of a Table

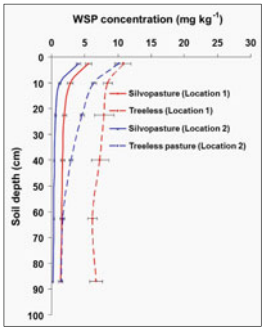
Nitrate–nitrogen concentrations by depth in silvopasture and treeless pasture sites at Location 1 in Florida, USA.

Depth, cm	Silvopasture	Treeless Pasture
	NO_3–N, mg kg^{-1}	
0 – 5	0.8(0.26)†	2.4(0.64)
5 – 15		
15 – 30		
30 – 50		
50 – 75		
75 – 100		

† Numbers in parentheses are standard errors

Fig. 9.6 Example of a table slide showing results of the study

Results: Example of a Figure



Water soluble P (WSP) by depth in silvopasture and treeless pastures at Locations 1 and 2 in Florida, USA
Error bars indicate standard errors.

- Brief description of results in bulleted form

Fig. 9.7 Example of a figure slide showing results of the study. Figure from Michel et al. (2007) with permission

- You may also opt to bold any numbers that have a special significance
- Fonts should be large enough to be seen from the back of the room; if you are not aware of the room size, use the font sizes suggested (Fig. 9.2)
- Use maps and photos if they will help to improve the quality of your presentation.

9.2.3 Conclusions/Implications

- The concluding slide(s) should summarize the main points of your talk (Fig. 9.8)

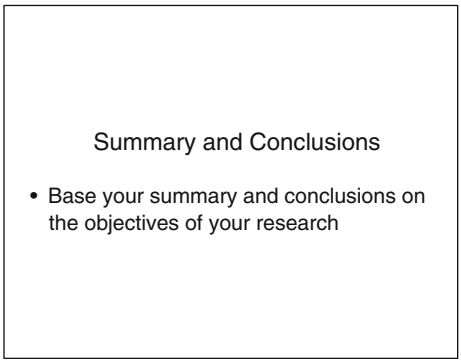


Fig. 9.8 Example of a Conclusions slide

- State how your objectives have been achieved and recommend the next phase of study
- A strong conclusion leaves a major impact on the audience, but the conclusion should be based on the data presented
- Follow up the conclusion with a slide to acknowledge the help of your colleagues, laboratory and field helpers, the funding agency, and others who have helped with your research
- Finally, a "Thank You" slide to signify the end of the talk.

9.3 The Oral Presentation

The following are some points for consideration to make an impressive oral presentation.

9.3.1 Before the Actual Presentation

- Practice your presentation a number of times to ensure that it is smooth and well within the allocated time
- Proofread all your slides for spelling, use of appropriate punctuation marks, units, etc.
- Use animation as needed but resist the temptation to overdo your animation: too many animations take up the precious time allocated for your presentation
- Practice the presentation to a small group of friends/coworkers prior to making your conference presentation, and encourage the group to provide input to enhance the quality of presentation (e.g., point out the areas that they cannot follow, where too much unnecessary information is provided, etc.)

- Avoid a monotone presentation; vary the tone of your voice to make your presentation lively and to emphasize important points
- Make sure that you are not talking either too fast or too slow, that there are no annoying "hm…," or "ah…," or "um…," and that your voice is loud and clear so that the audience can understand you easily—talking to your peers will help you with these issues
- If you do have a problem pronouncing some words, practice those words over and over again until you have the issue corrected; this will avoid your stumbling during your actual presentation and interrupting the smooth flow of your talk
- Revise your presentation based on the suggestions of your peers, and practice your presentation once again making sure that your revised presentation is well within the specified time limit and that there is time for a question/answer session
- Dress appropriately for the presentation; avoid wearing a hat or shorts and flip flops
- Arrive early enough at the venue of presentation to familiarize yourself with the room by locating any electrical switches and getting used to the operation of a laser pointer or any other gadget that you might be using during the presentation.

9.3.2 During Your Presentation

- The chair of your session will invite you to the podium and first provide the "rules" for presentation, which would include the allotted time, notification when you are nearing the time limit, and so on
- The chair will then introduce you briefly to the audience
- Start your presentation by thanking the chair for the introduction and greeting the audience
- Introduce the title slide and mention who your coauthors are
- Capture the attention of the audience when the title slide is projected, perhaps with a question that makes the audience want to listen to what you intend to present, or making an easily understandable and short, appropriate joke
- Give an outline of your presentation, followed by examples to illustrate the message you wish to convey
- Make sure, while moving from slide to slide, that your presentation flows well. You could say for example, "Now, I would like to explain …" or "Now we move on to …" or "The next slide gives an example of …" and so on
- Pause between each slide to give people time to take notes and to "digest" your talk
- Summarize your talk after the main body of the talk has been presented and identify the most important output from your presentation
- Thank the chair and the audience and invite them for discussion.

9.3.3 Some Additional Guidelines

- Avoid all inappropriate mannerism during the presentation such as fiddling with objects, pacing across the stage, gripping the podium, and all such actions that suggest nervousness
- Make eye contact with your audience as much as possible; do not look only at the screen nor stare at just one or a few; eye contact is a simple way of showing that you are in control
- Do not try to memorize and regurgitate everything that you want to say; maybe memorize and deliver the title and the first sentence or two to help you overcome any nervousness; from there on, "walk" through the slides and present your talk based on your practice and knowledge of the work without it sounding memorized and therefore awkward
- Never turn your back to the audience; avoid walking in front of the projector
- Do not read the text off the slide or notes
- Maintain a calm and natural posture all through; some gestures are appropriate and help to make your presentation more audience-friendly
- Use a pointer to draw attention to specific information on your slides, to guide the audience through your presentation, and to help them understand your talk better
- Make sure you use appropriate technical terms and simple words
- Take a brief pause to regain your composure if you stumble across a word or lose the flow of your talk
- Finish your presentation within the allocated time; never haggle with the chair for additional time
- Remain polite and friendly during the question/answer session; do not argue with or disparage a questioner.

9.4 Oral Presentations in Relation to Scientific Writing

As pointed out earlier, both scientific writing and oral presentations are forms of communication of your research findings to others working in the same field. While the content of both types of communications may be the same, there are some distinct differences as well. Words used in written communication are different from those in an oral presentation. Words such as "Now, I would like to explain …" or "Now we move on to …" are never used in scientific writing, although they are popular in oral communications. Irrespective of the way in which you choose to communicate your findings, your goal remains the same—to ensure that your research reaches others in your field. Oral presentations also provide an opportunity to "add a face to the words"; in other words, the author gets the opportunity to clarify doubts and explain things that may not be clear in writing.

Oral Presentation

- Keep your audience in mind
- Begin your presentation with a title slide that includes author names and affiliations
- Introduce your topic and provide an outline of your presentation
- Include the following sections in the presentation: Introduction, Objectives and Hypotheses, Materials and Methods, Results and Conclusions
- Include Acknowledgment and Reference slides as appropriate
- Note that bulleted points are easier to read than long sentences
- Use appropriate font size and colors for your slides
- Use tables or figures to present the information, but do not repeat the same information in tables and figures
- Maintain professionalism in manners and attire during poster presentation
- Maintain eye contact with audience
- Remain polite while answering questions.

Appendix 9.1: An Evaluation of Oral Presentations

Name of Speaker:

Name of Evaluator:

The Subject Matter

- Did the speaker show adequate knowledge of subject?
- Were significant points emphasized?
- Was the talk confined to assigned subject?
- Did the talk cover too much of superficial generalities?
- Was the talk presented at the audience's level of comprehension?

Comments/Ratings

Delivery/Presentation Style

- Did the speaker maintain eye contact, a forceful voice, and enthusiasm?
- Were the speaker's mannerisms, posture, and gestures appropriate?
- Were the main concepts developed in a logical sequence?
- Was the talk extemporaneous rather than reading to the audience?
- Was talk about the right length?

Comments/Ratings

Use and Quality of Visual Aids

- Were characters and features easily visible?
- Were images overly complex?
- Were visual aids legible and understandable?
- Were there enough (and not too many) visual aids?
- Did images clearly depict the points made?

Comments/Ratings

Audience Reaction and Discussion

- Was time allowed for discussion?
- Did the presentation stimulate discussion?
- Did the speaker show professional composure during questioning/discussion?
- Did the speaker react to criticisms or opposing views openly?
- Did the speaker respond adequately and clearly (including "I don't know")?

Comments/Ratings

Overall Rating (out of 10; 10 = highest)

Signature of evaluator/optional comments

Date

Chapter 10
Poster Presentations

Abstract A poster presentation is a visual communication tool and hence presents a different set of challenges than that of an oral presentation. Proper writing tools such as the format for tables and figures that are used for oral presentations and manuscripts are applicable to poster presentations as well. A poster should focus on presenting a single idea. It will have the same sections as in a written paper (the IMRAD format). The contents should be arranged to read down columns and from left to right. Bullet points may be used instead of long sentences. Use appropriate font size and colors and explain the abbreviations when first used in the poster. The poster should be "reader-friendly" and self-standing such that the reader should be able to understand it in the absence of the author.

Posters are used as an advertisement for a product, company, or department, or for presentation of research results. The focus of this chapter is on the use of poster format for communicating research results.

In scientific meetings and conferences, oral presentations used to be considered "superior" to poster presentations. The trend has now changed such that poster presentations are as good as oral presentations. Indeed, a poster presentation might even be preferred in certain circumstances:

- When it is necessary to discuss ongoing research with peers, without the burden of strict time limits that are characteristic of oral presentations, to get additional ideas
- When the research is part of a larger project and merits detailed discussion with other participants.

For the above reasons, poster presentations are now considered an important component of a graduate student's training, and conferences usually organize poster competitions for graduate students.

P. K. R. Nair and V. D. Nair, *Scientific Writing and Communication in Agriculture and Natural Resources*, DOI: 10.1007/978-3-319-03101-9_10,

10.1 "To Do" Prior to Creating the Poster

10.1.1 Prepare the Abstract

An abstract is an essential component of any conference, and the length of the abstract is normally dictated by the conference organizers. The contents of the abstract would follow the pattern discussed in Chap. 2. Some conferences request "extended abstracts" to be published in conference proceedings either before or after the conference. The length and formatting requirements of such extended abstracts will be stipulated by the conference organizers. Unlike the regular abstract, an extended abstract could include tables and figures that explain your poster presentation in some detail.

Unless required by conference organizers or by judges of a student competition, it is not recommended to include an abstract within a poster. The abstract takes up precious space within the allowable poster size and serves no additional purpose since abstracts are normally published prior to a conference and available to all registered participants. It is, however, suggested that the poster author carry a few printed abstracts to the conference to be handed out to interested discussants.

10.1.2 Determine the Poster Size

The size of the poster is generally set by the conference organizers and will be available at the conference website. It is important to keep to the specified dimensions to prevent your poster from hanging over the poster space allocated to you. Note in particular that sizes are specified by width first and then height: a 1.0 m by 1.5 m indicates a portrait format while a 1.5 m by 1.0 m indicates a landscape format. Some conferences may specify poster dimensions in non-SI units (e.g., in feet and inches) such as 3′ by 4′ for a portrait or 4′ by 3′ for a landscape format (See Appendix 4.1 for SI to non-SI conversions).

10.1.3 Identify Components of the Poster

The essential components of the poster are the same as of a research paper except that an Abstract may not be needed and the reference list will be much shorter than in a paper.

- Title
- Authors and their Affiliations

- The **IMRAD** Format:
  - **I**ntroduction (with hypotheses and objectives)
  - **M**aterials and Methods
  - **R**esults
  - **A**nd
  - **D**iscussion.

A few important references may be added; also, add acknowledgments when appropriate.

10.2 Creating the Poster

10.2.1 Layout and Format

Decide on a single idea to get across in a poster. Then draw a sketch of the poster on a piece of paper, keeping in mind the poster size as specified by the conference organizers. Figure 10.1 presents a sketch of a 1.2 × 1.2 m poster. The general trend is to present information in columns with the content from top to bottom and left to right.

Posters can be constructed using various software; however, presentation posters are usually made using PowerPoint.

- First, select the size of the poster under "page setup". The appropriate height to width ratio in PowerPoint for the poster size should be used so that the printed size is compatible to the size specified
- Then, add the information as in your sketch. The size of lettering should be large enough that they can be read by a person standing one to two meters away from the poster. Font size would vary depending on the type of font used. If the font is Arial, the following are suggestions for the font sizes: Titles, 72; Sub-titles, 54; Text, 30
- Minor changes to your sketch may have to be made to accommodate all the information and at the same time create an appealing poster.

10.2.2 Contents

The poster should tell the story completely even without the author being present. The contents should be simple and clear, and visually appealing. Preparing a poster requires all the attention and writing skills discussed in previous chapters. These include accepted ways of writing numbers and words, ways of writing dates, expansion of abbreviations when first used, use of SI units, scientific names and authority for plants and other biological organisms, proper writing of math symbols and equations, and consistent use of either US or UK spelling throughout the poster.

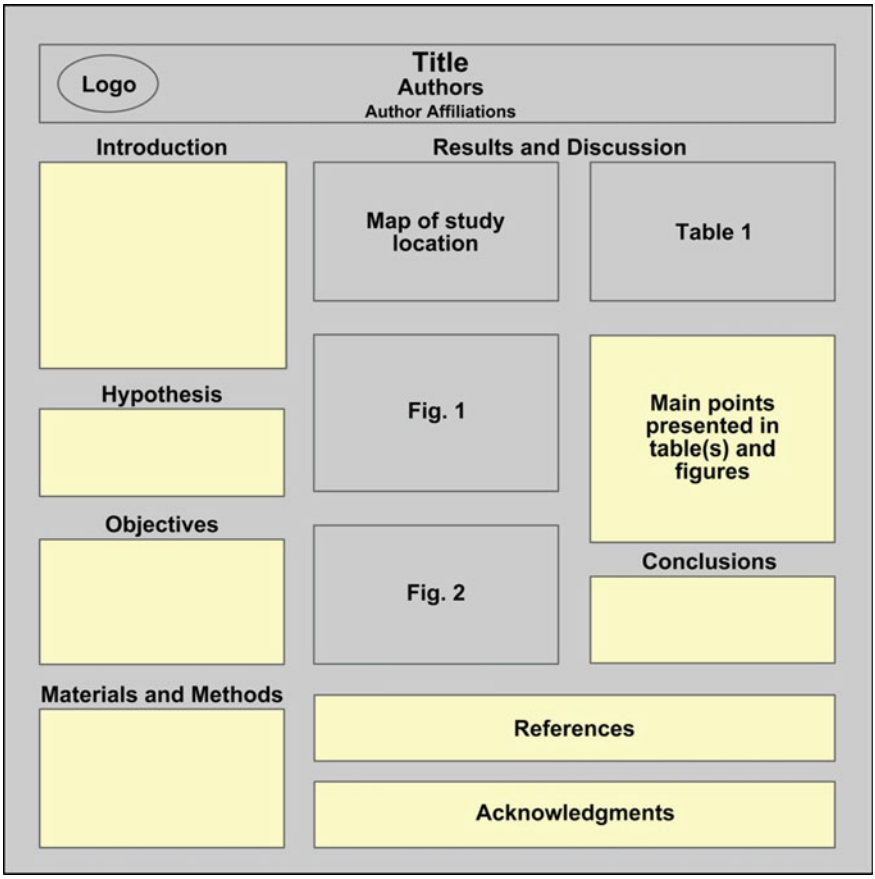


Fig. 10.1 Sketch of a poster 1.2 × 1.2 m. Note that this is only an example; variations to this sketch depend on poster contents

Title, Authors, and Author Affiliations: Title should be displayed prominently and in a font larger than that for the authors and their affiliations. Using lower and upper case letters normally makes for easier reading compared to all capital letters. Include the poster number provided by the conference organizers on the poster unless the number is already on the poster board. Identify the presenting author, usually by an asterisk (*) next to the name. Add "*presenting author" below the author list for clarification.

Introduction and Objectives: The Introduction should be brief. Bulleted text might be easier to read than long sentences. Make sure that the bulleted text is short; do not make a bullet a paragraph. Give the background information for the study. A few references (suggested maximum: four) may be included if needed. The introductory section should be followed by hypotheses and objectives.

Materials and Methods: Items under this section depend on the presentation topic. For field experiments, the study location should be included. If multiple locations are involved, a location map would be useful. Add photographs as appropriate. Often photographs can provide valuable information which might be difficult to explain in a couple of short sentences. If any specialized equipment is used, a labeled photograph would help in understanding the poster contents. If presenting the life cycle of an organism, use profuse illustrations.

Keep the methods brief; use only material needed for understanding the poster contents. You may have a vast amount of analytical data related to a specific topic, but include only the methods needed to explain your objectives. For example, a soil solution that is analyzed in a laboratory on an inductively coupled plasma (ICP) spectrophotometer gives a whole suite of elemental concentrations, but if only a couple of them are used in your presentation, then only those elements need to be mentioned in this section.

Results and Discussion: Now we come to one of the most important parts of your poster presentation—your results. This section includes both tables and figures. Diagrams or charts should be in a size sufficient to be read at a distance of 1–2 m. Use an easily readable font (e.g., Arial or Helvetica) for headers and figure captions. Avoid the use of a "fancy font" that distracts the reader's attention from the poster contents. Colors may be used for graphics; but avoid the use of too many colors that would distract the reader's attention from the contents. Also avoid a dark background for your poster that would mask the important contents in your tables and figures. In particular, do not use a pictorial background—forests, landscapes, etc.—as the background. Your poster is a visual communication tool that will serve as a source of information, a summary of your work, and an advertisement of your research. You need to be able to get your main points across to as many people as possible; nothing in the poster should adversely affect the attainment of this objective.

Tables and Figures: In a poster too, the tables and figures should be prepared in an identical manner to that for a journal publication.

- As mentioned in Chap. 2, tables are for presenting accurate numbers while figures show trends and features; choose the form that works best for presenting your data. Figures include charts, diagrams, graphs, photographs and other illustrations that would depend on the type of information generated by your research activities
- All tables and figures should be numbered serially (Tables 1, 2, etc., and Figs. 1, 2, etc.), and the table- and figure numbers should be cited in any explanation provided in the Results and Discussion section
- All tables should have a heading (above the table), and all figures should have a caption (below the figure), and all figures should contain relevant legends. Both tables and figures should include all essential components: units, statistical notations, etc., as in the case of research papers (Chap. 2)

- Make sure that tables and figures are self-explanatory: they should be independent of the text and each other
- While the format for tables and figures are similar to that for journal articles, space limitations in a poster makes presentation of information more challenging
- Table size should be limited to provide only information directly related to understanding the objectives of your research, figures could present data (as graphs) or other information such as maps or schematics
- Devise creative ways to make the poster appealing and at the same time present data effectively. Use colors for rows or columns depending on what you would like to emphasize. Bold any numbers that are of special significance
- Discussions should be brief; remember to cite tables and figures in your discussion
- Bulleted points make understanding of contents easier than long, winding sentences.

Conclusions* or *Summary and Conclusions: Present only the most important findings of your research. Make sure your conclusion ties up with the objectives of your research. Do not include too many speculations; you may want to include the next step in research activities if essential.

References: Due to space considerations, particularly for smaller poster sizes, provide only the absolutely essential references. The references could be of a smaller font size than for the other components of the poster. In the interest of space, you may want to remove the title of the reference from the poster. However, all author names and journal publication details should be provided so that anyone interested in understanding the topic further will be able to get hold of the publication.

Acknowledgments: Acknowledge all those who have helped you—but only them—if they are not authors in your poster presentation. These include all substantial help associated with field and lab work. The funding agency that provided support for your research should also be acknowledged.

10.3 Other Considerations for Poster Preparation

Balance: Make sure there is proper balance between the text and graphics. Main headings such as the Introduction, Objectives, and so on, should be clearly labeled.

Visual appeal: Do not cram and crowd the poster with too many details. Avoid the temptation to include all the information you have into a poster: nobody would want to read through all your fine text and numerous graphs and unwieldy tables.

Logos: It is appropriate to include logos such as those of your institution and/or the funding agency. These logos can be included near the title (Fig. 10.1).

Time needed: Creating a poster takes more time than most people estimate. Plan well ahead before the due date of the conference.

10.4 Presenting Your Poster

10.4.1 Before Your Presentation

It is strongly recommended that a draft of the paper be printed out and scrutinized for its overall appeal and appearance and potential problems such as spelling mistakes, missing units, and so on. Ask yourself if you would spend time on this poster if it were not your own. If not, what are the problems that you note?—too crowded, too many or wrong combination of colors, too small fonts for main headings? and so on. Get the poster reviewed by a colleague. Once all the final changes are taken care of, print out your final poster.

Practice what you intend to say to your audience. This is particularly useful for those who are presenting a poster at a poster competition. You may also want to keep with you enough supply of adhesives such as Velcro and drawing pins to affix the poster to the display board. Follow the instructions of the conference organizers, particularly in relation to the nature of the poster board. Are the poster boards Velcro-friendly? Print out several copies (smaller versions than the original) of your poster and your abstract to take with you to the display room. Once you are at the conference venue, identify the location for your poster, set-up your poster at the time specified by the conference organizers, and follow the conference organizers' directives regarding the times authors should be available, and when poster should be removed. If your poster has a table in front of it, place copies of the abstracts and the smaller-sized prints of poster on that table; alternatively pin these copies (in an envelope) on the poster board itself. You may want to leave a good supply of your business cards for the viewers to pick up, and leave a notepad for viewers to leave their comments and contact information.

10.4.2 During Your Presentation

Be at your poster well ahead of your presentation time and in proper attire (no shorts or flip flops). Explain your poster contents to those who stop by. Try to explain the contents of your poster in as few words as possible. Your audience will not have the patience to listen to a long lecture when they need to take a look at several other poster displays! Those who need clarification will ask you for more

information, which will then provide you with the opportunity to present a more detailed explanation of your poster. You will also have an opportunity to obtain feedback and additional input on your research from others who are working in a similar field, which could be very useful for taking your research to the next level.

10.5 Poster Evaluation

Evaluation of a poster in a student poster judging competition invariably addresses all the points mentioned above. These include quality of: Introduction, Hypothesis and Objectives, Materials and Methods, Results and Discussion, Conclusions and Recommendations and the overall impression of the judges. A typical example of a poster evaluation form is provided in Appendix 10.1.

Poster Presentation

- Keep to a single idea when creating a poster
- Keep to the size of poster as defined by the conference organizers
- Display the title of your presentation prominently
- Follow the title with author names and their affiliations
- Include the following sections in the poster: Introduction, Objectives and Hypotheses, Materials and Methods, Results and Discussion, Conclusions
- Include Acknowledgment and Reference sections as appropriate
- Arrange the poster contents to read down columns and from left to right
- Note that bulleted points are easier to read than long sentences
- Ensure that the poster is aesthetically pleasing to attract readers' attention
- Avoid using dark colors as poster background
- Use appropriate font size and colors for your poster display
- Explain the abbreviations when first used in the poster
- Use tables or figures to present the information, but do not repeat the same information in tables and figures
- Make sure that the presentation is "reader-friendly" and self-standing, i.e., the reader should be able to understand the poster in the absence of the author
- Maintain professionalism in manners and attire during poster presentation.

Appendix 10.1

Evaluation of Poster Presentations

Presenter's name _____ Poster # _____
(1 to 10 scale, 10 being the best/strongest)

Content

- Originality, need and significance
- Objectives
- Methodology
- Data/information presented
- Analyses and results/discussion
- Conclusions; Scientific contribution.

Presentation

- Display and aesthetics
- Format: Arrangement and organization, flow of sections
- Ability to stand alone
- Overall appeal.

Additional Comments

Evaluator's name and signature: _____

Date:

References

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Strunk W Jr, White EB (2000) The elements of style, 4th edn. Longman, New York

Additional Reading

A standard dictionary, such as Oxford or Merriam Webster

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Subject Index

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