

# SCIENTIFIC WRITING: STRUCTURE, FORMAT, STYLE AND OTHER ATTRIBUTES OF A RESEARCH PAPER

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# Outline

- Why should we publish?
- How to write a publishable articles?
  - Structure, format, and style
- How to review manuscripts for research journals?

# Why publish?

- Primary mechanism of communication
- The difficulties caused by not recording knowledge in writing: Inca civilisation
  - Inca Empire flourished in South America from 1200 to the late 1500s when it was destroyed by the Spanish invaders, the *Conquistadors*
  - Inca *King Parachuti VII* banned writing

# Why should scientists write research papers?

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

*Publish or Perish*

Publish and Prosper

# Why is good writing important?

- In scientific research, our immediate products are often publications.
- Highly competitive endeavour
- Most journals receive more papers than they can publish: best journals have high rejection rates
  - *Nature* rejection rate 91.95% (2008)
- Poorly written papers will be the first ones to be rejected
- If your article is to be read, it must be presented well.
- Good writing is also an essence of ‘marketing’ research.
- Market your product: Style is as important as substance. Good packaging cannot make up for poor content; but poor packaging can mask the quality of content

# Types of research publications

- Original research articles
- Book chapters and Review articles
- Research notes/short communications
- Conference presentations
- Theses and dissertations
  - embody results of research on a specific topic undertaken in fulfilment of the requirement of advanced degrees at master and doctoral levels.
  - short lifespan; it is customary that results from theses and dissertations are published as journal articles soon (usually within two years) after the student's graduation.
- Monographs and research reports: embody results of several years of research, often by a team of scientists, on a specific topic.
- Books
- Book reviews
- Annual reports
- Project proposals
- Posters

# Writing A Research Paper

## When to write:

- When the research has advanced enough and reached a distinct stage
- When you have new and original results to be reported
- (Lesser “ripe” results are reported in annual- or other periodic reports)

# Writing A Research Paper....

## How to proceed:

- Overcome the “fear” complex
- Be sure that you have enough message to deliver
- Develop a plan for the article
- Write the first draft
- Revise/correct the first draft
- Make a second draft
- Check for details (references, tables and figures, ...)
- Give it to colleagues for reading
- Prepare the final manuscript
- Submit it to the journal

# Where To Report

## Choosing a journal -- international or local

- International journals:
- More prestigious (than local ones);
- Wider readerships
- Higher standards and rejection rates;
- Publishing in international journals requires more efforts, but is more rewarding in the long run.

# Journal articles based on location-specific research

- Application-oriented because of institutional mandate, funding restrictions, etc
- ‘What’ vs. ‘why’ and ‘how’ types of research
- Research should be aimed at
  - establishing cause-effect relations
  - and exploring the principles that form the basis of observed behavior.
  - revision of accepted theories or laws in the light of new facts,
  - or practical application of such new or revised theories or laws

# Structure of a Research Paper

## The **IMRAD** Format:

- **I**ntroduction
  - **M**aterials and methods
  - **R**esults
  - **A**nd
  - **D**iscussion
- Title, keywords, abstract, tables/figures, and references
  - Different journals and disciplines have different norms and styles
    - Various style manuals and books
    - Instructions to Authors
    - **Bottom line for all is that scientific writing should be clear, concise, and coherent.**

# Title

- General pattern of readers' approach : title, abstract, graphical results (tables and figures), materials and methods, discussion
- Statistics show that for every person who reads the full article, 10 will look at the tables and figures, 100 will read the abstract, and 1000 will read the title.
- Titles should reflect the content accurately and adequately.
- Avoid abbreviations, formulas and jargon, verbs, be easy to understand; and report the subject of the specific research rather than the results.
  - Broiler visceral offal meal increases performance of laying ducks
- **Word limit for most journals is 15 or less.**
- Avoid low-impact words such as 'effect of,' 'study of, and 'influence of'.
- The titles should not be too brief or bland; it should be intellectually stimulating.
- **Flashy titles (e.g., 'Agroforestry can stop deforestation' should be avoided for journal articles.**
- If the title suggests an innovative investigation such as 'Does nearness to markets affect inclusion of dairy cattle in the farming system: A case study from xx region of xx country' 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.

# Authors

- Only people who have made an important contribution to planning and carrying out the research are listed as authors.
- Technicians and other helpers are usually mentioned in the acknowledgments.
- Each co-author should give final approval to the version that is to be published.

# Keywords

- Indexed by abstracting services.
- Words that appear on the title should not be repeated as keywords.
- Keywords should be mentioned in the abstract of the paper.
- The number of keywords is usually limited to five, may be six. These should be 'words,' not phrases or long clusters of words.
  - multileveled tree/non tree crop and livestock systems
- Common words such as plants, animals, soils, models, and people are too general to be of any value as keywords

# Abstract

- Abstract/summary is an abridged version of the article
- **Definitive not descriptive:** Give facts rather than say the paper is 'about' something.
- Provide the information itself, instead of saying 'the effects are described,' mention what the effects are; and, instead of saying 'the factors will be presented,' say what the factors are.
- **150 to 250 words; is written in one paragraph (multiple paragraphs may be allowed for review papers)**
- should stand on its own
  - a statement of rationale and objectives
  - methods used
  - main results including any newly observed facts
  - principal conclusions and their significance.
- Should be written in the past tense and should contain no information or conclusion beyond those found in the article
- should not contain literature citations or references to tables or figures

# Introduction

- Why the research was carried out?
- Give the reader the background that is needed to understand the paper
  - nature and extent of the problems studied
  - relates the research to previous work (usually by a brief review of the literature, but only that which is clearly relevant to the problem)
  - explains the objectives of investigation,
  - defines any specialized terms or abbreviations used in what follows.
- **Avoid repetition**
  - do not repeat the Abstract in the Introduction or the Introduction in the Discussion. Do not go into an extensive literature review.
- **Do not repeat well-known facts, nor state the obvious**

# Materials and methods

- Reproducibility of results
- What has been done, when, and how, and how the data have been analyzed and presented.
- Make sure that there are no ambiguities in abbreviations or names, all quantities are in standard units, all chemicals are specifically identified, experimental designs and details are stated, nothing is included that does not relate to the results that follow, and that there are no unnecessary details that may confuse the reader.
- It is customary to write Materials and Methods in past tense.
- Do not go overboard with excessive description of common procedures.

# Results

- Follow the same order as you gave the objectives in the Introduction
- Report only representative data rather than endlessly repetitive data.
- Do not report large masses of data
  - Reduce them to statistically analyzed summary forms
  - Present in tables or figures along with essential statistical information to understand and compare them (least significant differences and multiple range test in tables and standard error bars in figures).
- Repeat in the text only the most important findings shown in tables and graphs
  - include negative data – what was not found if (but only if) they affect the interpretation of results
  - in the text, refer to every table and figure by number

# Results (contd..)

- In the text, write single-digit numbers in words unless followed by a unit
- But do not start a sentence with a numeral even if followed by a unit (e.g., Twenty hectares – not 20 ha)
- While presenting an approximate value, use a definite number not a range (e.g., approximately or about 200 plants, *not* approximately 80 to 200 plants) and
- In text, use 'to' instead of a dash to express a range (e.g., 2 to 4 animals, not 2–4 animals)
- The text be short and objective without verbosity
- The data need to be presented simply and clearly, since they represent new knowledge emerging in the world
- The tendency to repeat in words results already exposed in figures and/or in tables, a recurrent error, mainly in young researchers, should be avoided

# NUMBERS, DATES, UNITS, ABBREVIATIONS, AND NOMENCLATURE

- Accepted ways of writing numbers and words
- Accepted ways of writing dates
- Units: SI units and conversion of non-SI units
- Abbreviations
- Acronyms
- Scientific name and authority
- Math symbols and equations

# Tables and figures

- Include only tables, figures and graphs that are necessary, clear and worth reproducing
- Tables and figures are used to present data (quantitative data, illustrations for trends or comparisons) that cannot clearly be presented in text.
- While tables present accurate numbers, figures show trends and features.
- Do not present the same data in tables and graphs.
- Each table and figure should stand on its own.

# TABLES

*Tables are for presenting precise numerical data*  
*Graphs are for illustrating trends or relationships*

Preparing tables:

- Table number and title
  - Column headings
  - Row headings
  - Field or body of the table
  - Footnotes

...

# TABLES ....

- Do not cram too much data into a single table
- Limit decimal points to two; choose appropriate units to avoid large numbers
- Avoid using dash (-) in tables; indicate if data not available or applicable
- Use a zero (0) before decimal for values less than 1 (e.g., 0.5 kg)
- Present only analyzed, summarized data, not raw data
- Make the tables self-standing (self-explanatory)

Table 1. Belowground nutrient stocks of 21-yr-old *Grevillea robusta* stand and treeless control at one meter soil depth in central Kerala, India.

Soil depth (cm)	Soil nutrient content (kg ha <sup>-1</sup> )					
	Nitrogen		Phosphorus		Potassium	
	G. robusta	Treeless control	G. robusta	Treeless control	G. robusta	Treeless control
<b>0-20</b>	255.76 <sup>a</sup>	261.97 <sup>a</sup>	16.90 <sup>a</sup>	14.53 <sup>a</sup>	311.68	250.44 <sup>a</sup>
<b>21-40</b>	159.60 <sup>b</sup>	152.93 <sup>b</sup>	13.46 <sup>ab</sup>	10.98 <sup>b</sup>	228.14	147.97 <sup>b</sup>
<b>41-60</b>	122.85 <sup>bc</sup>	117.76 <sup>c</sup>	11.68 <sup>bc</sup>	8.25 <sup>c</sup>	201.97	148.01 <sup>b</sup>
<b>61-80</b>	92.25 <sup>cd</sup>	71.24 <sup>d</sup>	10.03 <sup>bc</sup>	6.03 <sup>d</sup>	190.04	143.20 <sup>bc</sup>
<b>81-100</b>	62.50 <sup>d</sup>	46.42 <sup>e</sup>	8.21 <sup>c</sup>	4.71 <sup>e</sup>	152.34	137.28 <sup>c</sup>
<b>Total</b>	692.96	650.32	60.28	44.5	1084.17	826.9

Means with the same superscripts do not differ significantly within the same column (P <0.001).

# ILLUSTRATIONS

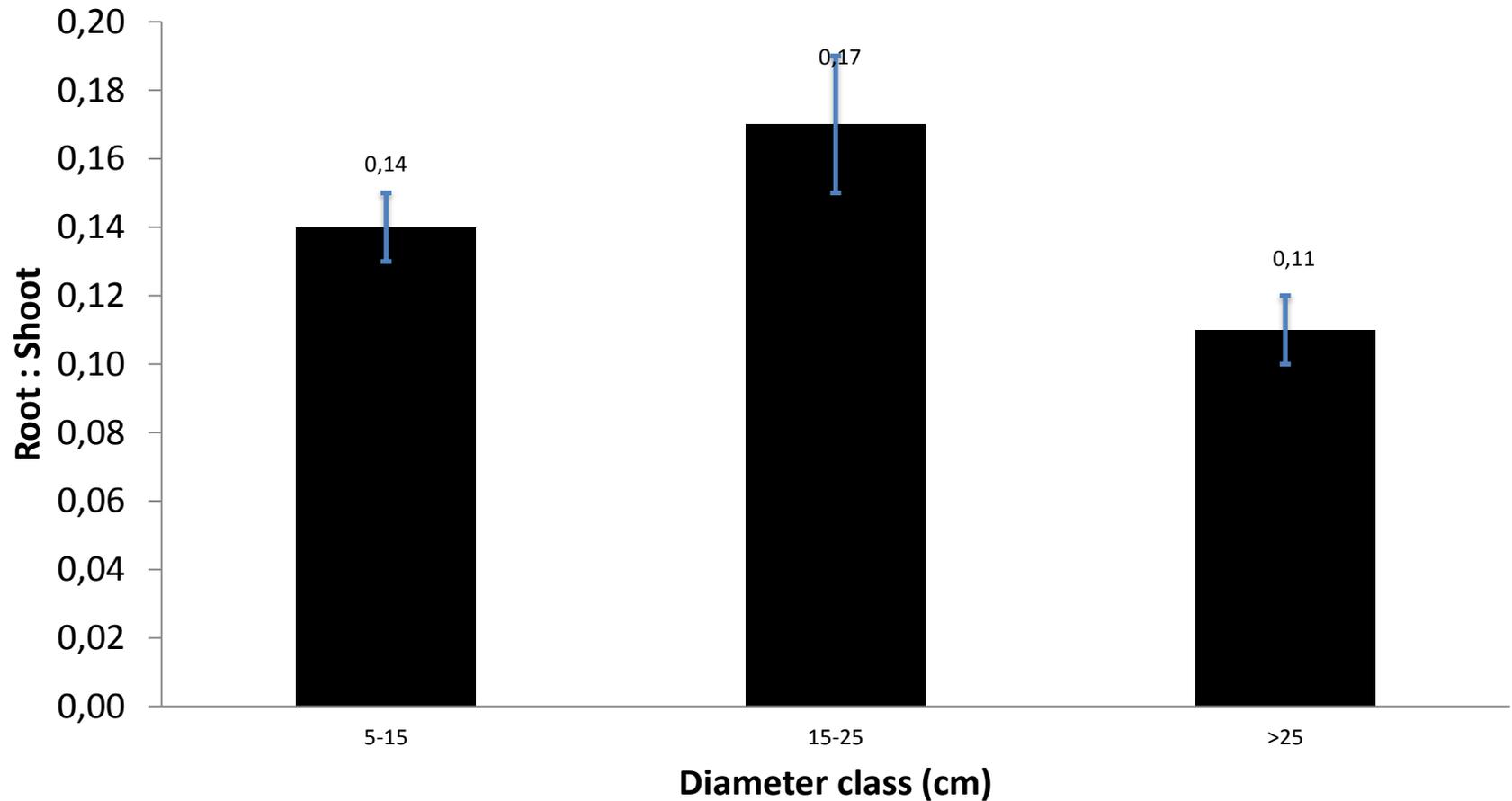
- Simple and clear
- Contain relevant legends
- Self-explanatory (independent of text and of each other)
- Visually appealing (not crowded)
- Organized in the way they present data

# ILLUSTRATIONS.....

## Types:

- Line graphs
- Bar or pictorial graphs
- Pie charts
- Photographs
- Flow charts
- Maps

Figure 1. Root shoot ratio among different tree size classes for 21-year-old *Grevillea robusta* in central Kerala, India. Error bars indicate SE.



# Common mistakes in reporting results

- If the data are plotted, then don't include a table of data as well.
- The caption with any figure or table should include all pertinent information
- Raw data are not usually included in your results (e.g., absorbance, relative mobility, etc.).
- Use an appropriate number of decimal places. The number of decimal places and/or significant figures must reflect the degree of precision of the original measurement
- Do not draw conclusions in the results section

# Discussion

- Show the importance of your work through analytical interpretation
  - The reader should not end up saying, ‘So what?’
  - 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 previously published work.
- Speculations and conjectures would attract criticism
- Present the theoretical implications of the work.
- Suggest future research needed to follow up.
- State conclusions, with evidence for each.
- Problems: authors simply state – often repeat – the results
- Move away from the stated objectives and ‘solve all problems’

# Do not take your interpretations too far!

- “Sherlock Holmes and the mystery of stars”
- Conclusion should, rather than just repeating results, state well-articulated outcome of the study and briefly suggest future line of research in the area based on findings reported in the paper.
- *Non Sequitur* (“It does not follow”): This is the simple fallacy of stating, as a conclusion, something that does not strictly follow from the premises.
- Mismatch between stated objectives and discussion/conclusion is a very common problem in manuscripts.
- All sections of the paper should be tightly and coherently tied together.
- *Superficiality*: The purpose of a discussion is to interpret the results, not to simply state them in a different way.
  - What is the basis for expecting a particular result? Explanations may not be easy and your explanation may not be correct....

# References

- Most journals list literature in author-date system, but some follow the numbering style. Better to follow the journals' Instructions to Authors and look up the recent issues of the journal
- *The Chicago*, APA (*American Psychological Association*) and CBE (Council of Biology Editors) style manual
- Journals usually allow only about 25 references for a research article and publications that are 'old' (published more than 15 years age) are discouraged (unless they are seminal works).
- Repeated references to the same author's various publications on the same topic, no matter how outstanding that author is, may also be avoided.
- gray literature: Limited-circulation publications and work in progress, e.g., working paper, discussion paper, abstract of paper presented at a conference, extension pamphlets..
- Manuscripts 'in preparation' or 'submitted' or 'in review'
- 'personal communication'/'unpublished data'
- Online resources

# Units

- SI system (Syste`me International d' Unite´s)
- SI units are indicated by the respective symbols in singular and without periods (full stops)
  - g, kg, cm, m, h, and so on, for both singular and plural usages
  - leave a space between the numeral value and the unit (6 m, 25 kg)
  - When reporting yields, the term Mg ha<sup>-1</sup> is preferred; do not write 'metric ton'.

# Language and style

- Clear, consistent, logical, and coherent
- *ABC* of science writing
- Scrutinized by a science editor.
- *Verb tense*: use past tense to describe events that have happened.
  - E.g., procedures that you have conducted and results that you observed.
- Use present tense to describe generally accepted facts.
- Reference to results of a specific study should also be in past tense.
- Mixing tenses is even worse.
- *Subjectivity and use of superlatives*: ‘huge,’ ‘incredible,’ ‘wonderful,’ ‘exciting,’ etc
- *Grammar and spelling*:
- *Inaccurate word or phrase*:
- *Anthropomorphism*: a type of oversimplification that helps the writer avoid a real explanation of a mechanism

# *Hedging*

- An expression of tentativeness and possibility
- Expressing statements with precision, caution, and diplomatic deference to the views of colleagues.
- In science, hedges play a critical role in gaining ratification for claims from a powerful peer group by allowing writers to present statements with appropriate accuracy, caution, and humility.

# CHARACTERISTICS OF A GOOD SCIENTIFIC PAPER

## Style:

- Present new and original results and an accurate account
- Be clear, concise, and easily understood
- Follow the specific disciplinary style
- Be free of slangs and jargons
- Be free of objectionable and plagiarized materials
- Have adequate and relevant illustrative materials

# Guide for reviewers: to assist in formulating the comments

- Does the subject fall within the general scope of the journal?
- Is this a new and original contribution? (For review articles this does not necessarily apply.)
- Are interpretations and conclusions sound, justified by the data and consistent with the objectives?

If the answers to any of the above three points are negative, please give clear arguments for rejection of the paper on the review form.

# Guide for reviewers (contd..)

If the answers to the above three points are positive, then please continue with the following.

- Does the title clearly reflect the contents?
- Is the abstract sufficiently informative, especially when read in isolation?
- Are appropriate keywords given?
- Is the statement of objectives of the article adequate and appropriate in view of the subject matter?
- Is the description of materials and methods sufficiently informative to allow replication of the experiment?
- Are the statistical methods used correct and adequate?
- Are the results clearly presented?
- Is the organization of the article satisfactory?
- Does the content justify the length?
- Are the figures and tables all necessary, complete (e.g. titles) and clearly presented?
- Are the references adequate?
- Is the English correct and understandable to a multidisciplinary and multinational readership?
- If the paper deals with animal experimentation, could any aspect of it be seen as having caused unnecessary suffering?

## Common Reasons for Rejection of a Manuscript

Broad categories	Specific weaknesses
The manuscript is not appropriate for the journal	<ul style="list-style-type: none"> <li>• Outside the scope of the journal</li> <li>• Interpretations/conclusions range beyond what can be reasonably concluded based on the data presented</li> <li>• Repetitive information not sufficiently new and original contribution</li> <li>• Highly location-specific study – does not allow generalization outside the location of the study area.</li> </ul>
Substantial weakness exists in the article	<ul style="list-style-type: none"> <li>• Poor presentation and trivial treatment</li> <li>• Language errors: Poor grammar, punctuation, or spelling</li> <li>• Typographical errors</li> <li>• Weak content</li> <li>• Inaccurate information or references</li> <li>• Lack of clarity</li> </ul>
Problems in the format of the manuscript	<ul style="list-style-type: none"> <li>• Does not conform to the journal's format</li> <li>• Poorly chosen title or one that is incongruent with the article</li> <li>• Jargon is used that may be unfamiliar to many readers</li> </ul>
The article may not conform to editorial priorities	<ul style="list-style-type: none"> <li>• Contradicts a certain aspect of the stated editorial policy</li> </ul>

# References

- Nair P. K. R and Nair V D. 2014. *Scientific Writing and Communication in Agriculture and Natural Resources*. Springer 142p.
- APA 2001. *Publication Manual of the American Psychological Association*, 5th ed. American Psychological Association, Washington, DC
- ASA 1998. *Publications Handbook and Style Manual*. American Society of Agronomy, Crop Science, Society of America, Soil Science Society of America, Madison, Wisconsin, USA.
- Bazerman C 1985. Physicists reading physics Schema-laden purposes and purpose laden Schema. *Written Communication* 2(1): 3–23.
- CBE Style Manual Committee 1983. *CBE Style Manual: A Guide for Authors, Editors, and Publishers in the Biological Sciences*, 5th ed. Council of Biology Editors, Bethesda, MD, USA.
- Strunk Jr. W. and White E.B. 2000. *The Elements of Style*, 4th ed. Longman, New York.
- *The Chicago Manual of Style*, 15th ed. 2003. University of Chicago Press, Chicago, USA.
- Wager E., Godlee F., and Jefferson T. 2002. *How to Survive Peer Review*. BMJ Books, London, UK.



**Thanks...**