ARTICLE

How to write and publish articles in plant breeding: What do we need to know?

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Abstract: *Social, economic, and cultural globalization and the consumer society have enabled science to definitively participate in people's daily lives. Human knowledge has advanced at an extraordinary rate; science has become present and imperative; and never has more been expected from scientific advances than now. Here I addressed answers to the following questions: What is the importance of science? How can science be correctly communicated? What can we learn from comparing articles from Mendel and from Watson & Crick? How is a scientific paper to be written? How are target journals for publishing articles to be chosen? What is the impact factor of a journal and the h-index of a researcher, and what importance do they have? What is the role of authors, editors, and reviewers in the publication process? What are the main scientific databases? What are predatory journals/publishers and their consequences for science? What are particular features of articles in the area of plant breeding? Finally, in what directions is science moving, considering that it has come to stay?*

Keywords*: Science, paper, scientific writing, impact factor, h-index, predatory journal.*

IMPORTANCE OF SCIENCE

Science began its ascent to notoriety in human society in the transition to the Middle Ages after translation of the texts of the great Greek philosophers to Latin. The West became aware of Aristotle (384-322 BC), the great Greek philosopher, and especially his inductive-deductive scientific method in 1150 AC. Aristotle thought that all people have a natural desire to know. In 1270, centers in Spain and Italy began translation of the Aristotelian works "Posterior Analytics" and the "Corpus Aristotelicum" to Latin. Aristotle's inductive-deductive scientific method used inductions from observations to infer general principles and deductions from those principles to verify further observations. Induction and deduction cycles would allow the advancement of knowledge. Science, as well as Aristotelian inductive-deductive method, and its conceptual evolution, are discussed in Gauch Jr. (2003).

The Brazilian physician, bacteriologist, epidemiologist, and sanitarian Oswaldo Gonçalves Cruz (1872-1917), a pioneer in the study of tropical diseases and founder of the current Oswaldo Cruz Institute, always believed in science as the most viable means for development of societies. His is the famous and visionary statement, "Meditate on whether only strong nations can perform science, or whether science is what makes them strong". In the 1910s, Oswaldo Cruz, applying all his scientific knowledge and his determination,

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was decisive in combatting the main diseases that ravaged Rio de Janeiro, such as bubonic plague, yellow fever, and smallpox (Brito 1995).

Social, economic, and cultural globalization and the consumer society at the end of the twentieth century were the backdrop that enabled science to participate in people's daily lives in a definitive manner. Never has science been as present and necessary as now; never has human knowledge been so vast; and never has so much been expected from scientific advances as today. Science is definitely here to stay.

Certainly, the relevance of science can be evaluated in various manners; there are various criteria and various methodological approaches. The UNESCO Institute for Statistics (UIS) approach (UIS 2021) will be adopted here, which assesses the importance of science in countries by their investments in research and development (R&D) in terms of percentage of their gross domestic product (GDP), along with the number of researchers per million inhabitants (Figure 1). The GDP is the sum of all goods and services produced by a country. According to data from the UIS (UIS 2021), global investment in R&D reached a record USD 1.7 trillion in 2019, and 10 countries alone were responsible for 80% of this investment. South Korea annually invests 4.1% of its GDP and has the largest number of researchers (6826) per million inhabitants. Japan invests 3.4% of its GDP and has 5328 researchers per million. Austria invests 3.1% and has nearly 5000 researchers per million. The United States invests 2.7%, with 4200 researchers per million. China, with around 2% investment of GDP, has little more than 1100 researchers per million. Brazil invests 1.3% of its GDP and has only 887 researchers per million, the smallest contingent of researchers among the 30 countries considered in Figure 1. It is estimated that in the coming decades, Brazil will need to triple its investment in science to reposition itself among the ten largest economies of the world. It is noteworthy that in the 1970s, the Brazilian and South Korean economies were equivalent. The spectacular growth of the South Korean economy was a result of its policy of encouraging R&D activities, with adoption of the creative imitation model, associated with reverse engineering (Lima 2017). This continual and growing encouragement of R&D activities made South Korea one of the leading countries in high technology, with the largest conglomerates of the electrical and electronic industry on the planet.

Another way of evaluating the importance of science is to accompany the evolution of worldwide production of scientific articles, which reached 2.55 million in 2018 (Figure 2). Among the countries that most produce articles, China is first (21%), followed by the United States (17%). The European Union, however, produced more than China or the

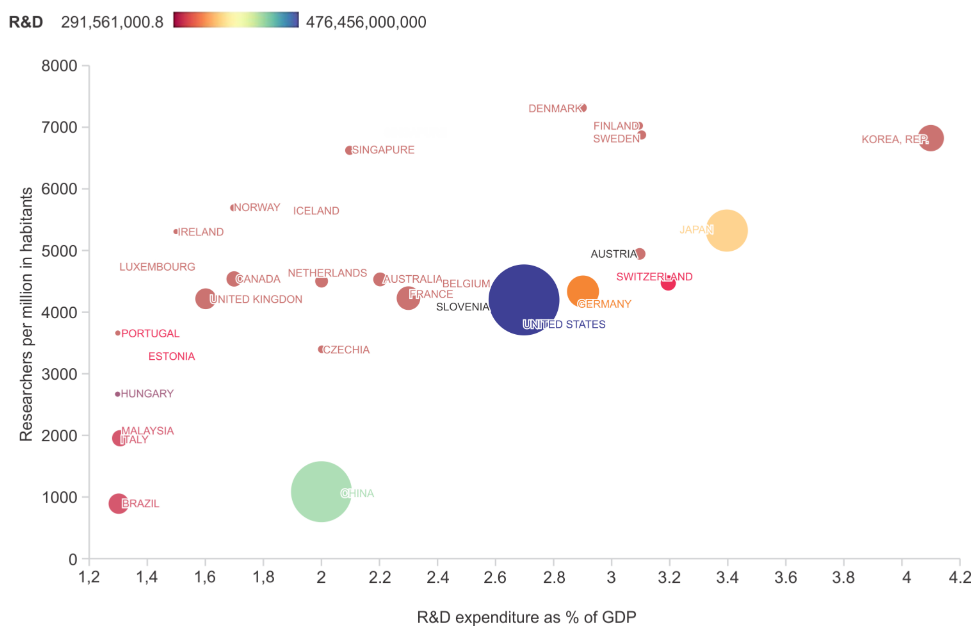

Figure 1. Investments in research and development (R&D) in 30 countries in terms of percentage of their Gross Domestic Products and the number of researchers per million inhabitants. Circle sizes are proportional to the absolute values of investments of each country. Source: Adapted from UIS (2021).

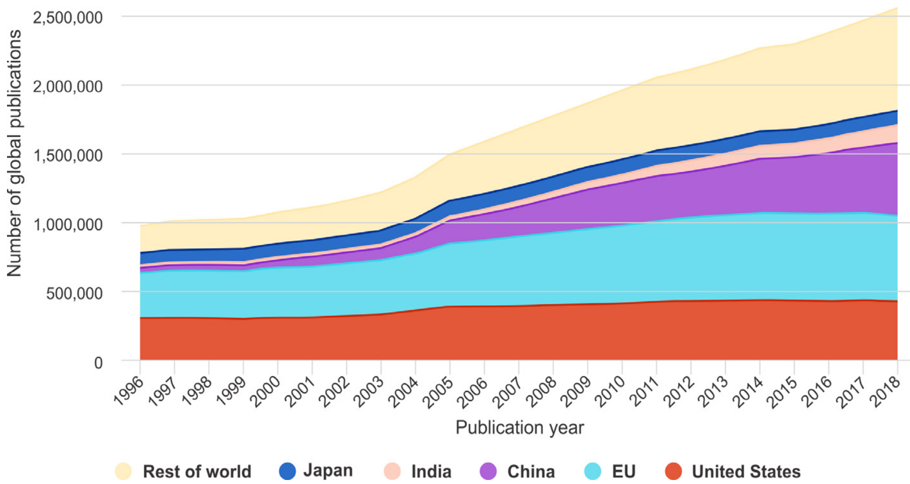

Figure 2. Number of articles published by countries, economic block (European Union), and the rest of the world from 1996 to 2018. Source: National Center for Science and Engineering Statistics (NCSES) of the National Science Foundation (NSF); Science-Metrix; Elsevier, Scopus Abstract and Citation Database (https://ncses.nsf.gov/pubs/nsb20206/publication-output-by-region-country-or-economy).

United States, at 24% (Figure 2). While considering the rapid growth of scientific production in China, the National Science Foundation (NSF) evaluates that articles from the United States and from the European Union will continue to have the greatest influence and impact in the world. Developed economies (USA, European Union, and other similar economies) accounted for 56% of worldwide production of articles. Countries of medium to high economic development (China, Russia, Brazil, and other similar countries) accounted for 34%, and 9% of this production was in developing economies (India, Indonesia, Pakistan, and similar countries). In that same ranking in 2018, Brazil was in eleventh place (2.35%), however, with a mean annual growth rate of 5.42%, compared to mean growth worldwide of 3.83%.

Although the growth in Brazilian scientific production is expressive, as shown by statistics, Brazil will need to produce an ever-increasing number of high impact articles, combining quantity with quality. The countries that have opted for science, such as the United States, South Korea, Japan, and others, now compete in a select market of high technology and high value-added products. Accumulated and focused scientific knowledge results in high value-added products yielded by highly qualified workers, who are therefore well paid. Brazil must combine its condition as largest exporter of agricultural commodities and minerals with the condition of exporter of innovative high-technology products arising from scientific knowledge. In the text below, a historic and emblematic comparison will be made between two prominent articles published by Mendel and Watson & Crick to highlight the importance of scientific communication. An alert from Bower (2011) is fitting: “The main purpose of scientific writing is not to present information, but to communicate it.”

MENDEL *VERSUS* WATSON & CRICK: AN EMBLEMATIC COMPARISON

A scientist needs to write, whether to sound new ideas or to expand existing scientific knowledge. To begin, each and every scientist can draft a text. However, good writing skills are rarely an innate ability. Science has long known that writing skills can and should be learned and refined. Thus, in general, good articles will emerge from scientists well trained in writing.

An emblematic example of the importance of scientific communication and understanding it is comparing the articles of Mendel (1865) and of Watson and Crick (1953) to see what can be learned from them. Gregor Johann Mendel (1822-1884), a Czech meteorologist, mathematician, biologist, physician, philosopher, and Augustinian monk, published his article “Versuche über Pflanzen-Hybriden” (“Experiments in plant hybridization”) in 1865 (Figure 3). The article of the American molecular biologist, geneticist, and zoologist James Dewey Watson (1928) and of the British molecular biologist, biophysicist, and neuroscientist Francis Harry Compton Crick (1916-2004) “Molecular structure of nucleic acids: a structure for deoxyribose nucleic acid” (Figure 4) was published in 1953. Mendel’s article was forgotten and only rediscovered 35 years later. The hereditary mechanism he studied and revealed in garden peas was also verified and confirmed in other plant species in an independent manner in 1900 by the Dutch scientist Hugo de Vries, the Austrian Erich Tschermak, and the German Carl Erich Correns. Watson & Crick's article revealing the molecular structure of DNA, however, had immediate repercussions.

Mendel, Gregor. 1866. Versuche úbera Plflanzen-hybriden.
Verhandlungen des naturforschenden Ver-eines in Brünn,
Bd. IV für das Jahr 1865, Abhand-lungen, 3–47.

EXPERIMENTS IN PLANT HYBRIDIZATION (1865)

GREGOR MENDEL

Read at the Debruçar 8th, and March 8th, 1865, meetings
of the Brünn Natural History Society

INTRODUCTORY REMARKS

EXPERIENCE OF ARTIFICIAL FERTILIZATION, such as is effected with ornamental plants in order to obtain new variations in color, has led to the experiments which will here be discussed. The striking regularity with which the same hybrid forms always reappeared whenever fertilization took place between the same species induced further experiments to be undertaken, the object of which was to follow up the developments of the hybrids in their progeny.

To this object numerous careful observers, such as Kölreuter, Gärtner, Herbert, Lecoq, Wichura and others, have devoted a part of their lives with inexhaustible perseverance. Gärtner especially in his work *Die Bastarderzeugung im Pflanzenreiche* [The Production of Hybrids in the Vegetable Kingdom], has recorded very valuable observations; and quite recently Wichura published the results of some profound investigations into the hybrids of the Willow. That, so far, no generally applicable law governing the formation and development of hybrids has been successfully formulated can hardly be wondered at by anyone who is acquainted with the extent of the task, and can appreciate the difficulties with which experiments of this class have to contend. A final decision can only be arrived at when we shall have before us the results of *detailed experiments* made on plants belonging to the most diverse orders.

Figure 3. First page of Mendel's article, translated to English in the book of William Bateson (1902). Source: http://www.esp.org/foundations/genetics/classical/gm-65.pdf.

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equipment, and to Dr. G. E. R. Deacon and the captain and officers of R.R.S. *Discovery II* for their part in making the observations.

[1] Young, F. B., Gerrard, H., and Jevons, W., *Phil. Mag.*, **40**, 149 (1920).
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[3] Von Arx, W. S., Woods Hole Papers in Phys. Oceanog. Meteor., **11** (3) (1950).
[4] Ekman, V. W., *Arkiv. Mat. Astron. Fysik.* (*Stockholm*), **2** (11) (1905).

MOLECULAR STRUCTURE OF NUCLEIC ACIDS

A Structure for Deoxyribose Nucleic Acid

WE wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey[1]. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces

is a residue on each chain every 3·4 A. in the *z*-direction. We have assumed an angle of 36° between adjacent residues in the same chain, so that the structure repeats after 10 residues on each chain, that is, after 34 A. The distance of a phosphorus atom from the fibre axis is 10 A. As the phosphates are on the outside, cations have easy access to them.

The structure is an open one, and its water content is rather high. At lower water contents we would expect the bases to tilt so that the structure could become more compact.

The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fibre axis. They are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other chain, so that the two lie side by side with identical *z*-co-ordinates. One of the pair must be a purine and the other a pyrimidine for bonding to occur. The hydrogen bonds are made as follows: purine position 1 to pyrimidine position 1; purine position 6 to pyrimidine position 6.

If it is assumed that the bases only occur in the structure in the most plausible tautomeric forms (that is, with the keto rather than the enol configurations) it is found that only specific pairs of bases can bond together. These pairs are: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine).

Figure 4. First page of Watson & Crick's article published in the journal Nature. Source: **Annals of Internal Medicine 138**(7): 582 (2003).

Incidentally, William Bateson, who coined the term genetics, not only disseminated Mendel's work, giving him due credit, but also advanced in his theory of heredity, devising new rules for the exceptions and new terms, such as alleles, homozygotes, and heterozygotes, and altering the Mendelian genetic symbology (Bateson 1902).

Back to our comparison, although 88 years separate the publication of Mendel's article from Watson & Cricks', the immediate success of the latter depended on the foundations of heredity proposed in the former. The question is – why did Mendel's article require 35 years for repercussions while Watson & Crick's had immediate repercussions? Various aspects were determinant. The first is that Mendel published his article in German, while Watson & Crick published in English, already the language of science at that time. Mendel's article is 47 pages long, whereas Watson & Crick's, fluent and concise, has only one and a quarter pages. Mendel published in the unknown journal Annals of the Nature Research Society in Brünn (*Verhandlungen de Naturforschenden Vereins in Brünn*, 4, 1865, published in 1866), of limited circulation, issuing only 500 copies. Watson & Crick published in the journal Nature, already well-established among scientists, with thousands of copies issued. From their fantastic discovery, Watson & Crick won the Nobel Prize in Physiology or Medicine in 1962. Lastly, the environment of the time that Mendel published was not prepared to receive his article. In contrast, an unveiling of the molecular structure of DNA was eagerly awaited.

Even though Mendel's article gave rise to a new science, Mendelian genetics, and its developments, such as plant and animal breeding, cytogenetics, and evolutionary and quantitative genetics, 35 years were necessary to rediscovery it. An intriguing question remains – would we now be 35 years more advanced in genetics if Mendel's article had had immediate repercussions? Perhaps not, because both Mendel and his article were quite ahead of their time. Those three and a half decades were necessary for emergence of an environment favorable for understanding Mendelian theory.

As for Watson & Crick, why was the birth of molecular biology not attributed to them? Why was the term "Watson-Crickian biology" not coined in honor of the ones who discovered the molecular structure of DNA, the cornerstone of molecular biology, just as occurred for "Mendelian genetics"? Questions like these have no answers. Science is practiced by people and is subject to every sort of event, from recognition to neglect.

In short, from this emblematic comparison, it follows that a good article should be written in the language of science, with fluidity and conciseness, and should be published in a high impact journal. In addition, a good article should be innovative, groundbreaking, purposeful, and based on a consistent experimental plan and on good and simple hypotheses to be tested in simple trials. All these aspects were quite evident in comparing the articles of Mendel and Watson & Crick.

Finally, it is necessary to emphasize the importance of reading for good writing; only those who read a lot write well. The path to fluent writing (with beginning, middle, and end) that is clear, objective, and concise is constructed from vast experience in reading. In addition to knowledge, reading offers an enriched view of styles to readers; many styles contemplated in reading allow readers to refine their styles or even develop them. A deeper discussion regarding good writing, with tips, suggestions, and recommendations, follows.

SCIENTIFIC WRITING

In the previous item, a "good article" was mentioned, though without indicating an adequate concept of the term. An article, according to the Brazilian Technical Standards Association (Associação Brasileira de Normas Técnicas – ABNT) (NBR 6022, 2003, p.2), is a publication with declared authorship that presents and discusses ideas, methods, techniques, processes, and results in the most diverse areas of knowledge. However, expressed in a simpler though no less rigorous manner, an article is any and every publication based on the scientific method. Several important books appropriately work with the subject of scientific writing, including those of Day (1994), Gastel and Day (2016), Saramäki (2018), and Silvia (2018). There are also classic articles working with the same theme (Nair 2005, Carraway 2006, Singer and Hollander 2009, Bower 2011).

Literary language is connotative, leaving room for readers to form their own interpretation. In contrast, scientific language is denotative, that is, of single, precise, clear, and concise interpretation. Writing an article is the art of expressing thought well in the written form. The art of writing and writing style should not be confused. Style refers to one's own personal manner of expressing thoughts. Critical reading of an article by specialized colleagues, a very common practice among European and North-American scientists but not very frequent among Brazilian scientists, should respect the overall style of the author and nearly always be limited to scientific questioning. Nevertheless, this does not impede critical readers from being able to contribute to improving the author's style.

Articles can be standard type or otherwise a case study, short communication, or note. The standard type, and in large part the others, has a fixed structure divided into a pre-textual part (Title, Authors and Affiliations, Abstract, Keywords), textual part (Introduction, Materials and Methods, Results and Discussion), and post-textual part (Acknowledgments and References). It is the typical IMRAD (**I**ntroduction, **M**aterial & Methods, **R**esults **a**nd **D**iscussion) model proposed in the 1940s and consolidated in the 1970s. A review article does not follow this structure and is intended to analyze and discuss already published articles aiming to describe the state-of-the-art on a given subject.

A detailed discussion on the structure of an article begins with the **Title**, which can be called its calling card. In general, it should be clear, short, concise, precise, direct, specific and sufficient to reflect the content of the article and be able to make an impact. Great care must be taken in choosing and organizing the words of the title. The title is of such importance that the recommendation is to create it after the article is ready. Once again, the titles of the respective articles of Mendel and Watson & Crick provide examples: "Versuche über Pflanzen-Hybriden" ("Experiments in plant hybridization") and "Molecular structure of nucleic acids: a structure for deoxyribose nucleic acid". Two particular items stand out in these examples: the precise, short, concise, and clear title of Mendel's article, though in German, and the title and subtitle structure used by Watson & Crick, an interesting strategy when one wishes to emphasize and define the subject. In addition to the standardized title, there are at least two more models: the conclusive title, derived from the result of the study, and the interrogative title, derived from the hypothesis of the study. When well composed, these last two may have a greater impact on the reader.

The **Abstract** is a mini-article; the second calling card of the article. Its importance is shown by the attention placed on it by journals, defining its size (150 to 300 words, in general), and it is generally written in a single paragraph in the past tense. It should be remembered that many readers will only read the article (or not) after reading the abstract. For that reason, like the title, the abstract should be clear, concise, precise, and sufficient to reflect the content of the article and be able to make an impact. Given its importance, the recommendation is also to draft it after the article is ready. As the abstract is a mini-article, there is a comprehensive technique for writing it. Generally, the first two lines should explain the importance of the study. Then the aim of the study should be reported in one or two more lines. The materials and methods and the results should involve around three lines each. Finally, the implications of the study should occupy the last two lines of the abstract. Naturally, these limits are flexible, and the idea of dividing the abstract in lines is to ensure that the entire study is well portrayed in it. In the abstract, just as in the full article, the main idea should be to "communicate more with fewer words".

In general, authors have placed little attention on **Keywords**. Yet their importance should not be underestimated, since they index the article in the internet search engines. All search engines, such as Google, operate using algorithms that scan the network in search of words coinciding with those desired by the researcher. Therefore, keywords should be carefully chosen to allow the article to be listed in the first positions when searched for. The repercussion of the article is also related to this choice. Journals normally limit this section to five or six keywords. The keywords should be different from those contained in the article's title in order to increase the possibility of recovering it in a possible search.

The **Introduction** section, as the name implies, is to introduce the subject, describing the state-of-the-art. It is written in present tense. The guiding question here is: What is the problem? Therefore, the aim in this section is to clearly describe the problem, review it in a detailed manner, present the methods of investigation already used for studying it, and report on the main results and conclusions already published. Only statistics from national or international institutes of high reliability should be used (for example, the IBGE or FAO). The main articles on the subject are reported, giving preference to those published by reputable scientists in high-impact journals. Citations of citations should be avoided (Cortez 1968, cited by Souza 2021, for example), except in cases where recovering the original article is impractical. Furthermore, original sources should be placed in references, so as to validate the quality of the article and recognize the pioneering status of these sources.

It is crucial that, along with the reports of the various findings provided by the references cited, the reader be informed about what missing information the article will provide. The introduction section generally occupies a page and a half of the article already in its format for publishing, that is, in diagrammed form. Three pages of text in Times

New Roman 12-point font, double spaced, and with 2 cm page margins correspond, on average, to a diagrammed page on the InDesign software. The last paragraph of the Introduction should contain the objective(s) of the study in a clear, concise, and precise manner.

The **Materials and Methods** section should be sufficiently detailed to be able to repeat the study. The guiding questions in this section are: What was studied and how was it studied? The materials (plants, animals, microorganisms, etc.) should be reported in detail, with technical specifications and the methods used (experiment site, experimental design and conditions, data collection and analysis procedures, etc.) so that other researchers can reproduce the experiment and verify the findings. The premise here is that if the experiment can be reproduced, so can its results. Do not be afraid of intense use of good statistics, because they validate the article. However, a warning is in order: the best statistics are not able to compensate for the nature of the data. There are no good statistics for bad data, as sophisticated as the statistics may be. Commonplace methods need not be detailed; it is sufficient to indicate references. New methods, however, must be described in detail. Original references of high relevance are to be cited in this section as well, avoiding citations of citations. This section should occupy one and a half to two pages and allow the use of subtitles, which should coincide with those presented in the Results section. Materials and Methods are to be written in past tense, because all procedures have already been performed.

Results and Discussion can be presented together or separately. There is no consensus on which format is better, and the final format nearly always depends on the journal chosen for submission. However, in both situations, the results should be presented in a fluent manner, along with any necessary figures and tables, always comparing the findings with the referenced literature. The guiding questions in this section are: What was discovered? What were the findings? Here it is important to keep in mind that such findings should be compared not only with those articles aligned with the results, but also with those articles in disagreement. An article will not be better if it compares and discusses only other articles with similar findings. Only findings/results should be presented and discussed, but this does not prevent perspectives and suppositions based on the findings from being suggested. Articles that outline perspectives and advance suppositions generally foster new questions and hypotheses, which, in turn, encourage new studies. In the last paragraph of this section, the big picture can be projected that allows advances from the findings of the article. The meaning of the findings should be emphasized in this section. The meaning of the results is to be developed in the **Discussion** section, presenting principles and generalizations from these results, considering the theoretical and practical implications of such results. Many articles are rejected because of gaps in the Discussion. The reader should not be left with the question “So what?” after reading the discussion. The Results and Discussion section is written in the past tense in two to three diagrammed pages.

Equally important is the **References** section. References of reputable authors, published in high-impact specialized journals are preferable, what are known as impact references. References of little relevance reduce the importance of an article. Impact references are of two types: recent and long-standing references. The latter are nearly always timeless through acknowledgment of the scientific community. Certainly, every good study mixes recent and old references, with common sense and balance. The number of references is also based on sound judgment. Review articles, such as those published by the “annual review” journals, frequently list from 100 to 200 references. Their purpose is to inform the reader regarding the state-of-the-art of a subject, and many references are necessary. However, from 15 to 30 references are generally sufficient for a standard article. In addition, it is very important to certify that citations in the text are all in the References section and are corrected cited. Software programs such as Endnote and Mendeley facilitate this insertion and correct monitoring of references.

Special attention should be given to **Tables** and **Figures**. Various questions arise concerning them: How many and which tables and figures should there be? When does one decide in regard to presenting data and results in one or another? Which format should be adopted for one or another? Both tables and figures are equally important, and they should be used in combination, whenever possible, but without redundancy of information. Redundancy means repeating the information under the form of table and figure. It is likewise important to be clear that few data should be inserted in the text of the article itself; if data are numerous, they should be inserted in tables or figures. The number of one or the other is limited by need and, once more, by common sense. Generally, from one to five tables are sufficient, in combination with one to two figures. Figures may be photos, graphic displays, illustrations, etc.

It is important that both tables and figures be created with an uncluttered appearance, with little to no visual pollution. This is achieved by placing only what is strictly essential in them. Focus is necessary at the time of creating tables and figures so that only the most relevant information is inserted in them. In working with charts, it is important to remember that bars should be used for discrete data, whereas lines adequately represent continuous data. Texts and captions of tables and figures must be carefully prepared and must be self-explanatory. Acronyms (abbreviations) of the characteristics evaluated in tables / figures should be described in their footnotes.

Every journal allows space for the **Acknowledgments** section. Certainly, all research articles have some form of financial support, whether directly through funding the project or indirectly through research productivity scholarships granted to authors. Therefore, ethically, appreciation should be offered to the funding agencies that directly or indirectly supported the research that gave rise to the article. Currently, the funding agencies themselves warn the author of the article that neglects to mention their support. This section is not scientific; it is characterized by courtesy, ethics, and kindness.

The question often arises: Which section of the article should be written first? As there is no consensus, I believe Materials and Methods is the starting point. If the experimentation was completed and the data collected, it is time to prepare this section. It is even advisable that it be written during experimental planning and execution. That way, all the materials and procedures will be contained in the section, and inserting the methods will be enough to complete it. After that, the Results section should be prepared if the data have already been analyzed and interpreted. Writing the Introduction follows, already forming the basis for the Discussion that will follow the Results. The Introduction is often already in the research project presented, and it can simply be improved or condensed for adaptation to the article. Finally, to reiterate, special attention should be paid to creating the abstract and the title. They may dictate whether the article will be assessed or summarily rejected by the editors/reviewers.

In short, focus is imperative in writing an article. Short sentences; correct spelling; and linked, coherent, and consistent paragraphs and sections are fundamental, as if telling a story, a scientific story with beginning, middle, and end. Tables and figures that are legible and pertinent to the study should be inserted. Good, relevant, and current references are to be widely used. The best ideas call for the greatest effort. When the article is ready, it is time to choose the journal, the topic of the next section.

CHOOSING THE JOURNAL AND IMPACT FACTOR

The innovative article, well written in good English and well-illustrated by figures and tables, is only one of the difficulties in the process of scientific production. Choosing the journal for publishing the article (target journal) is also difficult, though equally relevant. Making a submission to the right journal begins by defining the profile of the article. For example, if it is on breeding, its profile may be more classical if conventional methodologies are used. In contrast, a more molecular profile will be presented by articles that involve the "-omics" area (genomics, proteomics, and metabolomics). Journals tend to publish in a specialized area; some publish articles mostly in the conventional breeding area, others have a more biotechnological profile, and others have a mixed profile. Naturally, submitting a conventional breeding article to a journal with an -omics focus may result in rejection for publishing. The opposite situation may also arise. It is necessary to define the profile of the article and the journals that are candidates for publishing it. Therefore, authors should be familiar with their target journals.

Having defined the target journals, how can one select the journal to which the article will be submitted? In this case, always "set your sights high", that is, select the one with the highest impact factor (IF) in the area of the article, as it is supposedly the "best". Obviously, the article will have to have quality and excellence for this endeavor. Authors generally know how to evaluate the quality of their articles, and this ability to evaluate is enhanced with practice and the experience of publication. The opinions of colleagues also help to qualify the article. The more regional or universal aspects of the article also have weight in selecting the journal. If it is of concern to a universal audience, then it is fitting to select an international journal of high IF. Otherwise, selection should be made for a regional / national journal with the highest IF. Most of the time, the IF directs the selection of journals for publication. Nevertheless, for North-American researchers, the IF is not the determining factor in the choice of the target journal. They place more importance on the target journals that provide the largest audience for their papers and then, within those journals, they choose the one with the highest IF. However, it is advisable not to overestimate the IF of journals, because it has its limitations, as argued by Garfield (2003).

There are platforms that assist in choosing the target journal, such as Elsevier Journal Finder (https://journalfinder.elsevier.com/), Spring Journal Suggester (https://journalsuggester.springer.com/), Think-Check-Submit (https://thinkchecksubmit.org/), and Jane (https://jane.biosemantics.org/). The first platform requires insertion of the title, abstract, keywords, and research field of the article. The second requires the title, the complete text of the manuscript, and the research field. The third presents categorized criteria to confirm the choice of the target journal. The last platform, called Jane (Journal/Author Name Estimator), requires the title and/or abstract of the manuscript to provide feedback on possible target journals.

The impact factor (IF) is a parameter that, in combination with others, is used for databases such as those of Clarivate (https://mjl.clarivate.com/home), of Scopus Elsevier (https://www.elsevier.com/pt-br/solutions/scopus), and of SciELO (https://www.scielo.org/) to quantitatively and qualitatively evaluate science. This area of evaluation of science is called scientometrics. Specifically, the IF, proposed by Garfield (1955), refers to the ratio between the number of citations received by articles of a journal in a given year and the number of articles published by the same journal in the immediately preceding two-year period. We take the journal CBAB – Crop Breeding and Applied Biotechnology as an example. Its IF disclosed in 2021 in relation to base year 2020 was 1.282 (Table 1).

Table 1. Calculation of Impact Factor (IF) of the journal CBAB – Crop Breeding and Applied Biotechnology for 2020, disclosed in June 2021

Year	Citations in 2020 to papers published in 2018-2019	Numbers of published papers in 2018-2019
2018	106	69
2019	76	73
Total	182	142

$$IF = \frac{\text{Citations in 2020 to papers published in 2018-2019}}{\text{Numbers of published papers in 2018-2019}} = \frac{182}{142} = 1.282$$

Source: Journal Citation Reports (https://www-webofscience.ez35.periodicos.capes.gov.br/wos/ woscc/basic-search).

It was not easy to obtain that result. To achieve that IF, CBAB built on a continuous history of publication since 2001; and now in 2021, it commemorates its 20-year anniversary. It focuses effort on rigorous selection of articles (only 2 of every 10 articles submitted are approved); rapid publication, an average of 120 days in 2020; publication entirely without charge; and free access to the articles published. CBAB operates with the ScholarOne (Clarivate) electronic article processing system, licensed by SciELO. It adopts double-blind peer review, with Brazilian and international specialists of the Web of Science (Clarivate Reviewer Locator); applies testing against plagiarism (iThenticate); assigns DOI (Digital Object Identifier – for article registration and search) and e-location (electronic location identifier – sole identifier within the issue) to articles, for it has continuous publication; and has published articles exclusively in English since it was created in 2001. It should be noted that to ensure publishing of articles without charge, CBAB relies on funding from the National Council for Scientific and Technological Development (CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico), the Coordination for the Improvement of Personnel of Higher Education (CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), the Foundation for Support of Research for the State of Minas Gerais (FAPEMIG - Fundação de Amparo à Pesquisas do Estado de Minas Gerais), and its sponsor Brazilian Society of Plant Breeding (SBMP - Sociedade Brasileira de Melhoramento de Plantas), as well as on logistical support from the Scientific Electronic Library Online (SciELO).

The IF, as reported, is not the only parameter used by scientometrics; however, it is certainly the most important. As seen above, it is a non-dimensional parameter that allows journals to be ranked according to their impact. Thus, in 2021 (base year 2020), journals such as Science and Nature have an IF above 40. Brazilian agrarian sciences include around 31 journals in the Web of Science, with an average IF of 1.080, ranging from 0.347 (Bioscience Journal) to 2.137 (Scientia Agricola). They had average growth of 35% in IF 2020 compared to IF 2019. We recognize that the rank of Brazilian journals of agrarian sciences is not good, because it does not do justice to the magnitude of Brazilian research and agribusiness. Indeed, Brazil should have more agrarian journals with IFs, and most of the IFs of greater magnitude. Yet, undeniably, Brazilian journals have advanced in quality, in search of excellence, which means not only to obtain the IF, but to advance in it.

Objectively, what does the term "impact" in science mean? A synonym here for impact is "repercussion"; the journal (and the articles published in it) that has more repercussion has greater impact and, supposedly, has greater quality. The concept of impact, however, does not discriminate possible high repercussion regarding a mistaken article or even one generated by fraud. Nevertheless, though it can be questioned, it truly characterizes journals quite objectively. And who assesses the IF of the journals? The databases themselves do; the Web of Science (Clarivate) and Elsevier Scopus make assessments, obviously for the journals that each one of them hosts, which are not necessarily the same ones. Clarivate discloses its Journal Citation Reports (JCR) in the middle of each year, which contains the IF of the journals included in its database. On June 30, 2021, the JCR of 2020 was disclosed referring to 20,942 science journals and social science journals, separately, produced in 113 countries, all indexed in the Web of Science. Of this total, 207 received their IF for the first time (https://clarivate.com/webofsciencegroup/web-of-science-journal-citation-reports-2021-infographic/).

A question common to all journals is how to leverage their IFs. There is no magic – to increase the IF, the journal needs to attract groundbreaking and innovative articles that practice good science. As shown in Table 1, IF is a ratio (fraction); journal editors only have control over the denominator of this ratio, that is, the number of articles published in the two-year period. If the denominator increases greatly (number of articles published) and this is not accompanied by proportional growth in citations (number of articles cited), the IF will plummet. The IF requires a great deal of attention and caution; if the journal leverages its IF in a given period, it tends to attract a larger number of articles, which may result in a decline in its IF in subsequent years. An additional recurring question is the relativity of the IF. IFs of journals from different areas cannot be compared. The biotechnology area, for example, contains journals with higher IFs compared to the area of conventional breeding. Theoretical and Applied Genetics (TAG) is one of the most highly regarded journals of genetics and molecular breeding and has an IF of 4.439. The journal Crop Science, with a mixed profile that is more conventional, has an IF of 1.878. TAG and Crop Science journals are equally prestigious by scientists in the field of agrarian sciences.

THE *H*-INDEX OF THE RESEARCHER

We comment on evaluation of journals mainly based on the IF. There is also a criterion of evaluation of the researcher, which was proposed by Hirsch (Hirsch 2005) and is, for that reason, called the *h*-index. The *h*-index refers to the number h of articles of a researcher that received h citations. Similar to the IF, the *h*-index is non-dimensional and aims at characterizing the scientific production of a researcher, based on the repercussion of her/his articles. For example, a researcher with 10 published articles will have an *h*-index of 4 if at least 4 of these 10 articles were cited at least four times each one. It is evident from the concept of the *h*-index that a large number of published articles is not enough; the important criterion is that the articles are cited. We imagine, for example, the *h*-index of two hypothetical researchers (A and B), where A has 100 published articles, but only 1 article cited, even though 53 times. In contrast, researcher B has only 10 published articles and received 20 citations, though also for only 1 of them. Therefore, the *h*-index of both is 1, since both received at least 1 citation of only 1 article. Though it has advantages and disadvantages, the *h*-index is a good parameter to evaluate the scientific productivity of a researcher, though it is not the only one. The *SP*-index proposed by Dodson et al. (2012) evaluates the scientific productivity of a researcher in a more rational way. For a given year, it combines the IF of the journal in which the article was published with the number of citations that the article received, and divides the product of the two by the number of articles the author published in that year. A key aspect is that all or most of these indices can be used together to better characterize the scientific production of a researcher.

Brazilian science should follow the example of science throughout the world and award its researchers by merit. A clear way of classifying researchers by merit in scientific productivity is to rank them, using these indices. In the near future, approval of research projects, allocation of research grants, encouragement of international publication, and awards for scientific merit will be based on these indices. This seems to be the trend. It is also likely that other indices will be added to these to improve evaluation of journals and researchers. Authors and editors need to be up-to-date and in tune with these new challenges that tend to intensify competition even more in the scientific community.

ROLE OF AUTHORS, EDITORS, AND REVIEWERS

In this competitive environment of scientific production, it is important to have a clear idea of the role of each agent in the process. The environment requires that the interests of authors, editors, and reviewers fully converge. Authors are interested in imparting their best results by publication of their articles. Editors are interested in leveraging the visibility of the journal by publication of high-quality articles with high impact potential. Outside of this beneficial interaction of interests, there are conflicts. Thus, understanding the process is essential for consolidating scientific production.

Assuming that authors have one or more high-quality articles, they still need to select the most appropriate and best journal to publish them. They should be as well informed as possible regarding their target journals. This includes clarity regarding the profile of articles the journals publish, the average time to publication, free access to articles or not, absence of charges for publication or a reasonable charge, a peer review system, editorial policies, full mastery of Author Instructions, and other aspects. It should be noted that mean time to publication is an important criterion in choosing the journal for publishing. For a large international journal, an average time of two months to carry out review of the article and around two months to publish it after review and acceptance is reasonable. This same time frame is not applicable to all national journals. Unlike international journals, national journals generally do not have a professional structure supported by a large publisher, and they often have numerous types of shortfalls, such as irregularity of the flow of financial resources and lack of qualified labor. This does not justify, though it does explain, the relatively long average times to publication of national journals.

Journals generally operate with a peer review process. There are three review systems: i) Double blind, which means that authors and reviewers are not revealed to each other. This includes most journals and, up to a certain point, favors ethics in publication. ii) Single blind, in which the reviewer is anonymous and the author is revealed. This system often leads to difficulties for authors of non-English language and countries, who at times complain of a certain disregard for their articles evaluated by reviewers who are native English speakers. iii) Open system, in which authors and reviewers are revealed to each other. This last system is still little used by journals. Nevertheless, the open system has grown in relevance with the movement toward "open science", a topic that will be discussed in new direction in science section. In addition, the author needs to discover if the target journals operate in an open journal system, with free access to articles. Naturally, journals that operate in that way achieve greater visibility and access and tend to be more popular in searches by authors.

Reviewers, just as authors, have a fundamental role in the process. First of all, upon being invited to issue an opinion on an article, reviewers should consider some questions: i) Is the article in their area of expertise? An affirmative response is necessary. ii) Is there a conflict of interest? Being free to issue an evaluation is likewise necessary. iii) Is there enough time to perform the review? It must be remembered that a good quality review occupies considerable time in one's schedule because it requires critical and detailed reading of the manuscript and development of critical analysis to evaluate it deeply. Having answered these questions and accepted the invitation to evaluate the manuscript, the reviewer should be guided by discretion. The entire process is confidential and, therefore, no information should be disclosed in its regard. After these steps have been carried out, it is time to critically read the article. The audience to whom the manuscript is directed should be compared with the audience of the journal. If these audiences coincide, the manuscript has been submitted to the right journal. Impartiality, courtesy, and constructive criticism should guide the review. The aim of comments, suggestions, and questions is to improve the article, proposing new reflections for authors. There is no perfect article; all could use improvement. New questions should be formulated to support an opinion: i) Is the article innovative or groundbreaking, or is it purely incremental science? ii) Does it contain new knowledge and can it have an impact? After that, comments and critiques should be offered section per section, beginning with the title, proceeding to the abstract and keywords, and so on. Objectives of the study should be compared with the results obtained, and the materials and methods used should be those most suitable and agreed upon. It is important to evaluate whether the references used are mostly current and are appropriate. Finally, a judgment from this appraisal is issued: whether the article is accepted or rejected, fully accepted, or accepted with modifications.

Editors always work to leverage the quality and visibility of their journals. They are always seeking innovations for their medium of transmission and improvements for their home page and social networks. But this is only the aspect of formatting the journal. Other aspects are more relevant and require more attention, such as the content and quality of the articles published. Editors always aim to include articles that are innovative, groundbreaking, and/or incremental in the sense of adding on to existing knowledge, whether from the conceptual or methodological perspective. Through this logic, the pre-selection of articles by journals is increasingly severe and intense. Knowledgeable of their craft, editors and their associates increasingly improve their discrimination ability, separating the article that will have an impact from the one that won't. Reviewers and editors observe all aspects of the article, such as good and novel hypotheses, texts written with fluency and good English, a correct experimental plan, adequate experimental replication in time and space, use of current references published in high impact factor journals, and tables and figures in adequate format and number.

This pre-selection of articles, ever more rigorous, requires a change in attitude from authors. It is no longer enough to submit an article with the standard letter indicating that the article is original and that there is no conflict of interest. The cover letter to the editor has now gained enormous importance. In it, the authors should emphasize what addition the article makes, its unique and innovative character, and its potential for a wide audience. Many journals currently require this cover letter in different formats. Some require that at least five notable sentences of up to 100 characters each be highlighted to represent the article. Variations on this same theme are common, but there is a single aim – an answer to following question from the editor: Why should the journal publish this article?

Editors should be concerned with the visibility of their journals, monitoring their Ifs. The IF values of the main Brazilian journals of Agrarian Sciences frequently oscillate. However, this oscillation is not common in international journals. On the contrary, their IFs tend to increase annually. There is a virtuous circle in these journals: journals with high IF tend to be chosen by authors. They receive a larger number of articles due to their high IF. This results in increasing rigor in selecting articles to be reviewed. Even so, those selected may be rejected during the review process.

A personal comment on the Brazilian scientific production process is fitting at this point. As it is relatively recent, it has some defects and obstacles that are not present in the international publication environment. Here, it is not uncommon for authors to be offended by rejection of their articles, and they contest the journal and its editors. In addition, Brazilian journals tend to have a longer average time to publication because of the predominantly amateur operational system, and also due to the limited number of Brazilian researchers willing to review articles. But, naturally, these difficulties tend to recede as the Brazilian scientific process matures, and this is already beginning to happen.

DATABASES AND PREDATORY JOURNALS

Without a doubt, science is moving in the direction of complete commercialization. That will result in more patents, more protected cultivars, and more paid articles. Historically, the United States has led the modern world since World War II, largely due to its ability to innovate in science. The U.S. invests heavily in science and technology in search of innovations that result in high-technology products, that is, high value-added products. Asian giants such as South Korea, Japan, and Singapore follow the same route. The world is ever more eager to consume technological products. From this perspective, a new type of colonialism is being established, technological colonization. The country that holds cutting-edge technology leads; the others come to be led.

The intellectual property and scientific business sector of the North-American giant of international news and of the financial world, Thomson Reuters, was acquired by Clarivate and definitively entered in the scientific community upon creating the Web of Science. This database covers 21.1 thousand journals throughout the world in multiple disciplines and with peer review and proposes to promote information intelligence (https://clarivate.com/webofsciencegroup/solutions/web-of-science-core-collection/).

Elsevier Scopus (https://www.scopus.com/home.uri), with a similar *modus operandi* and mission, covers 24.2 thousand journals (https://blog.scopus.com/posts/scopus-roadmap-whats-coming-up-in-2020-2021). In a certain way, the Elsevier Scopus database is the European counterpart to the dominance in scientific information imposed by the North-American Web of Science database.

There are many other important databases with different missions, such as PubMed (https://pubmed.ncbi.nlm.nih.gov) and DOAJ (The Directory of Open Access Journals) (doaj.org). In the academic community, Google Scholar (https://scholar.google.com) has been gaining importance for its wide scope. This database can be freely accessed on internet and is differentiated by indexing articles and books. While Web of Science and Scopus index only the journals associated with them, Google Scholar freely indexes journals articles from all databases. In addition, Google Scholar constitutes and stores researcher profiles.

Brazil has its international database, SciELO (Scientific Electronic Library Online), created in 1998 to meet the needs of scientific communication in Latin American and Caribbean countries. This database currently operates in 17 Portuguese and Spanish speaking countries and gathers more than 1000 journals. Its success stems from the fact that it is the only platform that monitors the performance of the journals associated with it every six months. Its advisory councils, composed of editors from related areas that are democratically elected by their peers for two-year terms, draw up the policies that will guide the course of the journals. In addition, SciELO offers benefits (free of charge) to its associated journals, such as licensing of the electronic article management system (ScholarOne, from Clarivate) and a preprint server (PKP), among others.

Brazil also has something similar to a local database, created and maintained by CAPES - WebQualis (https://sucupira.capes.gov.br/sucupira/public/index.jsf), connected with graduate studies programs in the diverse databases related to the programs and in the corresponding thematic areas. For example, for programs in the area of Agrarian Sciences I, the following five databases are considered: ISI – Science Citation Index, CAB – Commonwealth Agricultural Bureau (CAB, UK), BIOSIS – Biological Abstracts (BIOSIS, USA), SciELO – Scientific Electronic Library Online (Brazil), and AGRIS – International Information System for the Agricultural Sciences and Technology (FAO, ITA). WebQualis, according to CAPES, is the set of procedures used for stratification of the quality of intellectual production of the Brazilian graduate studies programs.

WebQualis classifies journals by large areas and categorizes them into eight classes: A1, A2, B1, B2, B3, B4, B5, and C. Journals classified as C are not indexed. Journals from B5 to B2 must be indexed in 1 (B5), 2 (B4), 3 (B3), or 4 (B2) of the five databases, respectively, of their area. As mentioned, for Agrarian Sciences I, the databases are ISI, CAB, BIOSIS, SciELO, and AGRIS. Impact factors published by the JCR (Journal Citation Reports) are required for the A1, A2, and B1 journals. Thus, if the journal has an IF ranging from 0.000 to 0.749, it will be classified as B1. An IF from 0.750 to 1.999 will be A2, and 2.000 or greater will be A1.

Editors, authors, and coordinators of graduate studies programs should be attentive to WebQualis, above all at the time of the Four-Year Evaluation of Graduate Studies Programs promoted by CAPES. CAPES classifies Brazilian graduate studies programs on a rising scale of excellence, ranging from 3 to 7. Implicitly, 7-level programs should publish their articles in B1, A2, and A1 journals. However, this does not prevent them from publishing in journals with lower classification. For that reason, CAPES developed a correspondence table through discounting at intervals of 15%. It is called "A1 article equivalent". An article published in an A2 journal, for example, is equivalent to 85% of an A1 article. An article published in a B1 journal is equivalent to 70% of an A1 article, and so forth. Whether to remain at the top or to aim for it, graduate studies programs should be concerned about which journals their graduate students are publishing articles in. It should be noted that WebQualis was implemented in Brazil in 2009, but underwent critical analysis only recently. Jaffé (2020) argued that WebQualis led to a sharp reduction in the number of citations received by Brazilian articles in comparison with Latin American countries. In other words, Jaffé (2020), based on data from Scopus, concluded that WebQualis hurt Brazilian science. More evaluations are needed in order to clarify the real contribution of WebQualis to Brazilian science.

A matter that has reached alarming proportions is predatory practices on the part of journals. To attain a consensus definition on this matter, Grudniewicz et al. (2019) published the result of a broad debate involving 43 representatives of the scientific community (scholars, editors, institutions, libraries, etc.) of 10 countries. The consensus definition reached was: "Predatory journals and publishers are entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practices." Predatory journals are reckless. They unduly appropriate a significant part of world research resources, mortally wound ethics in science, and cause irreparable damage to the system in sensitive areas such as health, food production, and others.

The term "predatory journal/publisher" was coined in 2010. From then to now, this type of journal has multiplied. This proliferation occurred due to the absence of a clear definition for the term that would allow the large databases and publishers to combat predatory publication. How do predatory journals/publishers act? They search articles published by the researcher (potential victim) and then send an e-mail to the researcher praising the publications and inviting the researcher to publish with them. In the body of the e-mail, which is generally confusing, they insert the website of the journal/publisher and some information that is nearly always false, to attract the researcher. On the website, they offer information such as a false IF, inexpressive editorial board, fictitious addresses, false indexing, and the icing on the cake – the promise of approval of the article in record time and without peer review. All this on a nearly always crude website with texts full of grammatical mistakes.

How can predatory journals/publishers be combatted and obstructed? Grudniewicz et al. (2019) believe that now that there is a consensus definition on predatory practices, it is necessary to implement educational campaigns that publicly highlight the issue. The authors created a website (https://osf.io/8xvpm) to act as an international collaborative observatory to compile data on the problem and combat this scourge that threatens the credibility of science. Yet they warn that as long as the measuring stick for science is the number of articles published by the researcher, predatory practices will continue in activity. The culture of "publish or perish" and the difficulty of distinguishing legitimate journals from illegitimate ones creates an environment favorable to the existence and proliferation of predatory journals.

SOME PARTICULAR ASPECTS OF BREEDING ARTICLES

There are some particular aspects of plant breeding that must be observed and followed to increase the chances of acceptance of the article. Even a modest breeding program involves a large number of genotypes in its initial stages. Such genotypes are placed to compete in an experimental design, generally various square lattices, aiming at selection of the best. In this initial step, and in general, the experiments are in a single site and involve a reduced number of replications. More advanced steps, however, operate with a small number of selected genotypes and require designs with a larger number of replications and experiments replicated in various environments (crop seasons, years, and sites). To illustrate in a precise manner, Vieira and Chen (2021) describe the pipeline of a traditional soybean program that releases a cultivar already in the sixth year, with three generations per year and trials in up to 15 sites. However, these same authors also describe the pipeline of a predictive soybean breeding program (using molecular markers for early selection, predictive genomic methods, three generations per year, and trials in up to 16 sites) in which it is possible to release cultivars already in the fourth year.

This synthesis of breeding programs shows that the time required for releasing cultivars is relatively long, from 6 to 10 years for annual crops and from 15 to 20 years for perennial crops (Chaves et al. 2021). This reality runs up against the need for the researcher to publish articles each year. However, it does not seem reasonable for the researcher to publish one or more articles at each advance in generations of the program in its initial stages, unless there is some relevant finding. In this case, the researcher should exercise creativity/inventiveness to propose new solutions for aspects that optimize the program and facilitate production of articles. For example, the "speed breeding" strategy proposed by Watson et al. (2018) promises to shorten average time for cultivar development in annual species. The technique involves growing plants under continuous light (20-22 hours/day) and allows up to 6 generations per year (for wheat, barley, and pea) and 4 (for canola), instead of 2-3 generations per year in the conventional technique. Another example is implementation of recurrent selection in papaya by Pereira and Santa-Catarina (2021), with an effective and unprecedented strategy in the crop, aiming at generating variability and new cultivars. These are examples of groundbreaking innovative strategies that can have an impact on breeding programs. All researchers should aim for these types of findings.

Studies with estimation of genetic parameters, an essential procedure for directing a breeding program, should operate with experimental data also obtained in various environments. The parameters will then be accurately estimated, free from genotype by environment interactions. Especially for widely-studied annual species, it is difficult to approve an article that deals with estimation of genetic parameters from experimental data obtained from only one site and only one year/crop season. Likewise, pathogen resistance studies require experimentation in more than one crop year to obtain more consistent results, which will increase the chances of the article being approved.

In the best journals, simpler studies of characterization and evaluation of germplasm through descriptors and molecular markers are losing importance. With gradual and continual incorporation of new generation sequencing (NGS), traditional characterization and evaluation of germplasm have had less impact. This leads to the recommendation that such studies involve a large panel of accessions and a large number of descriptors and markers and that they be repeated in two or more consecutive years. Even more important is that such studies be linked to a breeding program – not characterization for characterization's sake, but rather characterization for breeding.

Biometry (here referred to as statistics applied to breeding) is generally not an end in itself. It is a means, even though it plays an important role in breeding. When connected with a breeding program, biometry is essential because it guides decision making and the direction of the program. However, applied in an isolated manner, it loses importance. Again, it should be emphasized – the most sophisticated biometry is innocuous when applied to inconsistent experimental data.

NEW DIRECTION IN SCIENCE

Again, science has entered into the daily life of all of us. It is not only governments that now base some of their most important decisions on science, but ordinary people also discuss scientific topics. Francis Bacon (1561-1626) believed science/knowledge is power and in the science's power as an instrument to serve human purposes (Gauch Jr. 2003). Therefore, there could not be a more favorable scenario for expanding research. Nevertheless, this comfortable scenario has been accompanied by a troubling aspect: the commercialization of science.

The large media groups did not quickly perceive the economic mother lode that science represents. However, when they perceived it, they cashed in. At first glance, the commercialization of science is not bad at all; after all, science only happens through financial investment. However, a deeper look shows that this may corrupt the ethical structure and impartiality that has always characterized the practice of science. Scientists always advanced in their studies and were continually monitored by peer review. The tough competition for resources and space in the scientific community led, for example, to the emergence and proliferation of predatory journals, nickel-and-dime journals. If you pay, they publish, "conveniently" dispensing with peer review.

Another controversial facet of the commercialization of science is the transfer of science investments of developing countries to the science of developed countries. Open access publishing (OAP) is a publication system that provides readers with free access to published articles and, for that reason, many governments encourage publication in OAP of studies funded by public resources. In the system known as Gold OAP, an article processing charge (APC) is paid to have the published article made available to readers for free. Ellers et al. (2017) warn that Gold OAP leads to redistribution of research resources to industrialized countries to support publication of free-access articles in "mega-journals" with more permissive acceptance criteria.

Ellers et al. (2017) analyzed data from a five-year period (2011-2015) of five mega-journals and found that researchers from developing countries published proportionally more articles in lower level mega-journals. These researchers paid APCs of articles that subsidized the publications in higher level mega-journals (premium journals) of the same publisher. Thus, researchers of developed Western economies published proportionally more articles in these premium mega-journals. Ellers et al. (2017) called the practice resulting from global inequality of the APC system "cross-subsidizing", and to illustrate it, they cited the publisher Public Library of Science (PLOS). From 2011 to 2015, the PLOS ONE journals maintained an average IF of 3.5 and published 31 thousand articles. However, their premium journals (PLOS Biology and PLOS Medicine) had average IFs of 10.8 and 14.7, respectively. Even charging high APCs ($2,900), these premium journals were not able to cover their high costs, above all because they published less than 10% of the articles submitted to them. However, the other PLOS ONE journals at that time had an average acceptance rate of 69%, directing their APCs ($1,495) to subsidize the premium journals. For Ellers et al. (2017), this inequality promoted by the OAP system must be eliminated, and publishers must be required to charge fair APCs (that reflect the real costs of publication) and the adoption of good publishing practices, with emphasis on ethics and transparency.

Yet not only publishers practice excesses. Some authors also practice science that is at least suspicious. Ioannidis et al. (2018) identified 265 authors in 37 countries, called hyperprolific authors, that published more than 72 articles per year, equivalent to 1 article published every 5 days. The study was carried out on the Scopus database, with data from 2000 to 2016. Ioannidis et al. (2018) sent e-mails to these hyperprolific authors asking how they achieved this impressive scientific productivity. The reasons alleged by the 81 hyperprolific authors who responded (of the 265 consulted) were hard work, love for research, advising many young researchers, leadership of one or more research teams, extensive collaborative work, involvement in multiple research areas, availability of expressive resources and data, availability of a large project, personal values such as generosity and sharing, and even sleeping few hours per day. Even more suspicious was to find that some hyperprolific researchers published many of their papers in a single journal. Here it is clear that the emphasis on quantitative scientific evaluation, in detriment to more qualitative evaluation, may be encouraging the rise of hyperprolific authors and explains why there were 4 in 2002, 39 in 2008, and 81 in 2016, as found in the study of Ioannidis et al. (2018).

But there is light at the end of the tunnel. The commercialization of science now faces a weighty opponent: open science, aligned with the digital age. Open science, according to Shintaku and Sales (2019) and NAS (2018), is a new way of practicing science, characterized by sharing data and ideas, greater transparency in the scientific process, greater collaboration between participants, and greater interaction with society. It is a worldwide movement that has gained supporters in academia and outside it. Open access to articles online is the best-known modality of open science, managed through the Creative Commons (CC) system (https://creativecommons.org/licenses/?lang=en). The CC-BY license allows redistribution, adaptation, and reuse of the article and of its data for any purposes as long as due credit is attributed to the original article. Article repositories such as SciELO Data (https://data.scielo.org/), arXiv (https://arxiv.org/), ResearchGate (https://www.researchgate.net/), PubMed (https://pubmed.ncbi.nlm.nih.gov/), among others, currently store and provide free access to published articles and the preprints. Preprints are the articles exposed to critical reading by the community and, for that reason, can gain a new dimension, even before being published. The DOI is attributed to the preprint, such that the article can be cited and may possibly gain various versions; however, all are public and accessible. Preprints can contribute to accelerate dissemination of knowledge, expand sharing, and even increase the quality of articles through the possibility of creating various versions of them (Packer 2021). Preprint is also a proposal of open science.

Furthermore, open science foresees implementation of the open system of peer review; when authors and reviewers are revealed to each other. This may be the most difficult change to implement in the review process of Brazilian journals. On the one hand, there is the perception that reviewers feel freer to issue their opinions under the double-blind system, when authors and reviewers remain anonymous. On the other hand, the academic community has been maturing and absorbing the rapid changes that the digital age has brought about in the scientific publication process, such as the open system. In short, open science focuses on ensuring the free availability and usability of papers, of research data and methodologies, including codes or algorithms used to generate this data (Shintaku and Sales 2019, NAS 2018).

Open Book Publishers (OBP, https://blogs.openbookpublishers.com/about/) is an international network of academics who believe it is time for academic publishing to become fairer, faster and more accessible. Barnes (2018), who is an editor at OBP, defined the different types of open access publication (OAP) by journals and books. Among the main types are Diamond/Platinum, Gold, and Green. The Diamond/Platinum is characterized by immediate OAP without payment of a fee. Copyright retained by the author, permission to share or reuse the publication, and use of the CC BY license are generally practiced. The Gold differs from Diamond/Platinum because the fee is charged. The Green can be freely accessed only after an embargo period, there may be barriers to reuse, and the author usually does not retain the copyright. Based on this classification, the CBAB journal is a Diamond OAP.

Returning to the situation of Brazilian science, it has in fact suffered from a reduction in funding for research and education. In 2017, according to Oliveira et al. (2020), the Ministry of Science, Technology, Innovations, and Communications (MCTIC, currently MCTI, Ministério da Ciência, Tecnologia e Inovações) had the smallest budget in the last 12 years, corresponding to 1/3 of the resources allocated to it in 2010. These authors indicated the close relationship between public funding and the growth rate in article publication (based on Scopus) for that same period (2010-2017). This rate was around 9% in 2010 and reduced to near 3% in 2017. However, these same authors did not explain the reason for the sharp and continuous decline in the publication rate of Brazilian articles beginning in 2006, which was around 30%, culminating in the 3% recorded in 2017. This was despite a sharp increase in funding from 2006 to 2010, the year in which the MCTIC attained its largest budget. In addition, the MCTIC is not the only government ministry to provide funding for research in Brazil, nor is Scopus the only database that monitors scientific information intelligence in the world, as already seen. Therefore, it is not only a question of reduction in funding, since, in 2019, Brazil invested 1.3% of its GDP in R&D (as shown in Figure 1), similar to Italy and Malaysia in terms of percentage, and similar to the United Kingdom in absolute amount, for example.

The Brazilian scientific community seems to have achieved maturity to make a self-critique. Emphasis on scientific productivism, represented by encouraging the researcher to publish more and more articles, has not led to the results that Brazilian national science policies expected. If, on the one hand, the heavy investment in science and technology (S&T) in the first decade of 2000 increased the visibility of Brazilian science, on the other, it did not result in growth of citations of Brazilian articles in the same proportion as investments made. So much so that for the next four-year evaluation, 2017-2020, CAPES requested that graduate studies programs list the four main products (articles, patents, cultivars, etc.) of greatest importance produced by its participant researchers. This new policy of CAPES indicates to Brazilian researchers that, from now on, the quality of their publications will be the focus of evaluation. The well-known slogan "publish or perish" in effect until now may be changing to "publish with quality or perish". Moreover, the option of the researcher for publishing with quality will take place in a scenario of modest investments in science, given the scarcity of resources of the country and the policies of recent years.

In 2020, the reduction in support for research in Brazil culminated in interruption of public funding for Brazilian scientific journals. Each year, the CNPq and CAPES issued public notices for investment in journals. There are more than 1000 journals, most of them dependent on this modest public investment, and they are now under serious threat of ending publication. Along with this difficulty is the loss (or even absence) of prestige of Brazilian national journals in the view of Brazilian researchers. They frequently deliver their best research results to international journals. Brandão et al. (2017) advanced possible reasons for this loss of prestige, highlighting the following two: i) the strong emphasis on the journals' impact factors by institutions that evaluate the performance of Brazilian research and ii) the understanding among Brazilian researchers, resulting from the first reason, that articles published in international journals have higher impact factors, confer greater prestige, facilitate approval of scholarships and projects, and leverage careers.

The situation described above impedes a virtuous circle of publication. According to Brandão et al. (2017), a journal that publishes high quality research motivates researchers to send new manuscripts with quality similar to those already published, thus contributing to an increase in the prestige and rank of the journal, which, in turn, leads to the submission of more quality manuscripts, and so on. The authors conclude the editorial by listing the attributes for internationalization of a national journal: *"the use of English as a lingua franca, professionalism, the employment of academic and/or full-time editors, editorial innovation, sustainability, credibility, adherence to good publishing practices, the use of adequate technology infrastructures, open access capabilities, and editorial transparency."* The above presentation reveals the sensitive and multifaceted aspects of the topic, which accommodates multiple solutions. We hereby suggest that funding agencies more strongly support Brazilian journals that have most of the attributes listed above to leverage them on par with their international counterparts. If that occurs, we will have the virtuous circle of publication so highly desired.

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