Science and the Public

Methods of Scientific Working (for Crop Sciences) (3502-440)

21 Jan 2025

Table of contents

1 Motivation

A large proportion of scientific research is supported by taxpayer's money. For this reason, the society can expect that scientific research provides a value for the society. This expectation, however, frequently leads to a conflict between scientists and society because scientists frequently like to work on problems that are quite basic or exotic, and on the first glance, far from any application.

There is a relationship between the wealth of a society and the scientific output, measured, for example as the rate of citations (Figure Figure 1). This figure suggests that it is worthwile to invest in basic scientific research.

Assuming that investment in science and education of scientists pays off for a society, one can derive from this various expectations of society and scientists. One of these requirements is that scientists communicate the results of their research to society. This requirement is increasingly more or less clearly imposed on science. A new dilemma arises for scientists:

- Science communication does not play a major role as a criterion for career development.
- Communication costs time and energy and distracts from the actually important work (research).
- Many scientists are not very well trained in science communication.

In the following, some of the basic principles of this communication will be presented. The following concepts are presented in this chapter:

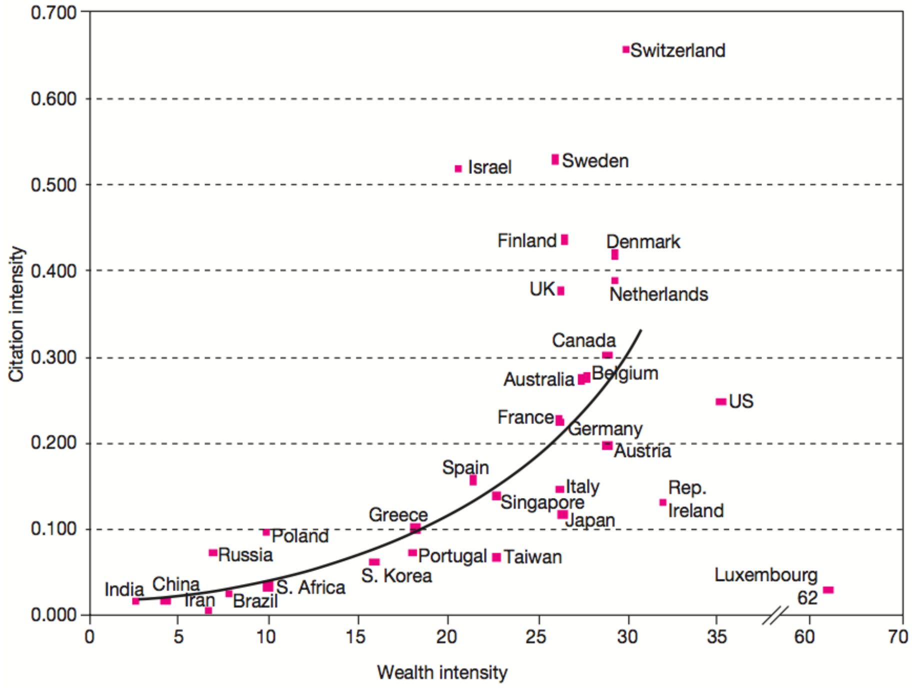


Figure 1 – *A comparison of the economic and the scientific wealth. The national science citation intensity is measured as the ratio of the number of citations of all papers to the national gross domestic product. Source: King (2004).*

- Transmission of information
- Corruption of evidence

2 The relationship between scientists and the public

Scientific research produces a variety of tangible output:

- Publications, i.e. primary scientific literature
- Patents, i.e. results that can be commercialized
- Products
- Personnel, which are people who were trained as scientists.

Science has the potential to return useful outputs to society. However, the interaction of science and the public is often difficult for the following reasons:

- Scientists are experts who produce primary literature
- The public rarely reads primary literature
- The connection between scientists and the general public is mainly through the media

This relationship can be rephrased in the schema shown in Figure 2.

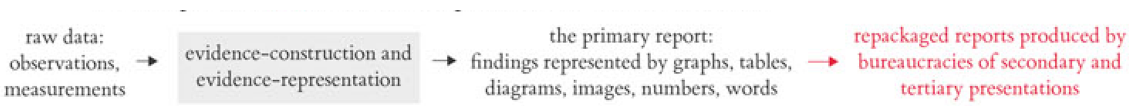


Figure 2 – *The transformations applied to scientific information on its way to the general public. Source: http://www.edwardtufte.com*

This problem requires to consider the interaction between scientists and the public. One needs to keep in mind that the public is usually more concerned about recent events and less so about important events, which however may be more important.

> *Recency of evidence decides relevance of evidence.* – Edward Tufte

In other words, the public is thought to be more interested in recent news than in more important news, which may not appear as urgent, relevant or interesting.

Tufte, who has thought a lot about the relationship between scientists and the general public, estimated the readership of scientific information:

Reviewers of submitted journal manuscript:	2-4
Readers of primary article:	100
Readers of abstract:	1,000
Readers of a news report about a scientific article:	100,000
Readers of the advertisement of the product:	1,000,000

In the conversion from a submitted journal manuscript to the advertisement of the product, the original content was repackaged several times, and it is not uncommon that some of the information in the original report was lost or changed. The repackaging of science from a primary into a secondary report has some important effects on the content:

> *The bureaucracies of secondary quotation edit, clarify, interpret, summarize, simplify, over-simplify, spin, tart up, mess up.* – Edward Tufte

Tufte called this transformation **evidence corruption**. On a further level, secondary may limit the access to primary reports by copyrights, costly subscriptions, overreaching claims of corporate privilege or government secrecy. In such a system, the public is kept off from relevant scientific results.

3 The dilemma of scientists

> *Without publicity a terrible thing happens - nothing* – P. T. Barnum

Scientists and scientific institutions are forced to market themselves to bring the message of their work (and their importance) into the public. However, there is the danger that a ‘pitch’ culture will arise in with the following consequences:

- **Exaggerated claims** of the importance of research results
- **(Over-) simplification** of research results to reach a broad audience
- **Cherry picking:** Only results that fits one goals or interests are advertised.

One consequence of this development is that each research institution of importance as press officers and rules and guidelines for scientists how to present oneself and the host institution in public. The dilemma for scientists is then that they usually prefer to focus on science, but on the other hand they recognize that it is important to present their research to the general public and to participate in the general (political) discussion.

The motivation for this is not only self-interest by pointing out that the research agenda is of public interest and requires for funding, but also that the results of one owns research are interesting and relevant for society. Another motivation for a public outreach of scientists is to motivate young people to study science and choose science a career path.

Several initiatives aim to establish a more direct contact of scientists with the general public. This approach is well developed in Great Britain, where were initiatives to improve the **public understanding of science** started as early as 1985 with the so-called Bodmer Report. Topics and activities for public understanding of science should include:

- Public controversies over science and technology
- Science communication in the mass media, internet, radio and television programmes
- Science museums, aquaria, planetaria, zoological parks, botanical gardens, etc.
- Fixed and mobile science exhibits
- Science festivals science fairs in schools and social groups
- Science education for adults
- Consumer education
- Public tours of research and development (R&D) parks, manufacturing companies, etc.
- Science in popular culture
- Science in text books and classrooms.

One outcome of these initiatives is the organisation Sense about Science (Weblink) in the UK, which describes itself as "is an independent charity that champions the public interest in sound science and ensures evidence is recognised in public life and policy making."

Meanwhile, similar activities were established in other countries as well.

In the US, a highly successful type of conference originated that aimed at the promotion of scientific (and other topics relevant for society) in 20 min talks that are aimed to promote a scientific topic or agenda in an entertaining but substantive manner.

Four good for talks related to crop science are:

- Pamela Roland, UC Davis: The case for engineering our food (TED Talk)
- Marcel Dicke, University of Wageningen: Why not eat insects? (TED Talk)
- Hans Rosling, Karolinska Institute, Stockholm: Global population growth, box by box (TED Talk)
- Laury Boykin, BioTeam Consultants: How we're using DNA tech to help farmers fight crop disease (TED Talk)

Whereas the ability to use modern technologies like social media to promote themselves and their work is appealing for more extrovert 'superstar' scientists. The problems in the complex relationship of research, patenting, the public and the superstar principle is nicely summarized in a blog report about the patenting of the CRISPR/Cas9 technology (Eisen, 2016).

Scientists have a fundamental conflict in their interaction with the public domain. They may exaggerate claims derived from scientific studies or problems of society such as climate change to attract more funding for their scientific research. This goal is frequently achieved by an appeal to catastrophy, by predicting dramatic consequences for the environment or society if not more research (and political action) are funded.

For this reason, any communication of scientists with the general public or with politics need to be factual, express limits of knowledge and communicate the risks and error margin of predictions. Scientists should also be aware to be called 'alarmists' (e.g., in the context of food security or climate change) and know the **prevention paradox**, i.e. being blamed that the situation did not develop as badly as they predicted if measures (based on advice from scientists) were implemented to prevent the situation. The corona pandemic provides many examples for this paradox.

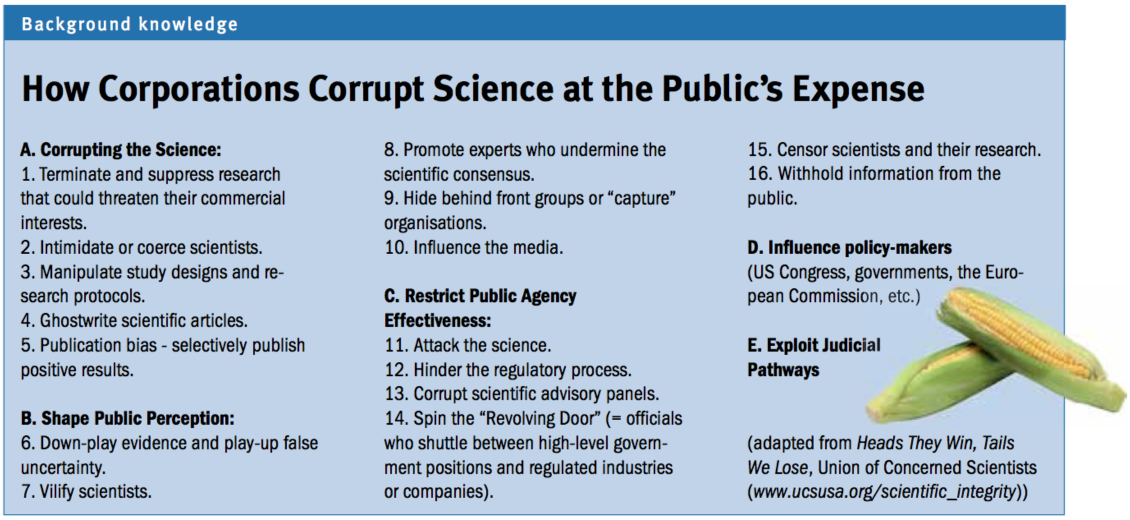
4 Science and the public in the field of crop science

In the context of crop science, there are several areas, in which the conflict between science and the public becomes eminent. A key characteristic of such interactions is that media tend prefer bad over good messages, and therefore the interaction is driven by a strategy of **fear, uncertainty and doubt (FUD)**, which is an effective communication strategy to fight opponents (Wikipedia).

Possible conflict areas involving crop science are:

- Global change: Real or not?
- Pesticides: Large scale pollution of the environment or not?
- Organic vs. industrial agriculture
- GMO technology vs. classical plant breeding

In this context it is interesting to consider the different strategies to corrupt science by interested parties (Figure 3). It should be noted that the list was made by the organization "Union of Concerned Scientists", which is a science-critical NGO that tends to criticize large corporations. Meanwhile, similar strategies can be found by organisations on the 'alternative' (or organic) sector, i.e. in the area of genetic engineering of plants.



Background knowledge

How Corporations Corrupt Science at the Public's Expense

A. Corrupting the Science:
1. Terminate and suppress research that could threaten their commercial interests.
2. Intimidate or coerce scientists.
3. Manipulate study designs and research protocols.
4. Ghostwrite scientific articles.
5. Publication bias - selectively publish positive results.

B. Shape Public Perception:
6. Down-play evidence and play-up false uncertainty.
7. Vilify scientists.
8. Promote experts who undermine the scientific consensus.
9. Hide behind front groups or "capture" organisations.
10. Influence the media.

C. Restrict Public Agency Effectiveness:
11. Attack the science.
12. Hinder the regulatory process.
13. Corrupt scientific advisory panels.
14. Spin the "Revolving Door" (= officials who shuttle between high-level government positions and regulated industries or companies).
15. Censor scientists and their research.
16. Withhold information from the public.

D. Influence policy-makers
(US Congress, governments, the European Commission, etc.)

E. Exploit Judicial Pathways

(adapted from *Heads They Win, Tails We Lose*, Union of Concerned Scientists (*www.ucsusa.org/scientific_integrity*))

Figure 3 – *Strategies for corrupting science as assembled by the Union of Concerned Scientists. Source: LabTimes 07/2013*

5 Precision agriculture

- Precision agriculture as an alternative to randomized controlled studies
- Everybody becomes a contributor (but not a designer!) of scientific studies
- Who owns the data and also the results, as well as any knowledge derived from it
- Scientific commons (analogy to the theory of the commons)
- Give examples
- some companies from the big ag
- Satellite surveillance
- Pathogen detection, e.g.,

- Discussion: how would this fit into a classical model of formalized hypothesis testing? Are there any analytical models to detect meaningful or causal patterns in the data?

6 Citizen science

Why citizen science: - Relevant problems - Rapid transfer into practice

Disadvantages (let students discuss): - Many people need to be convinced, therefore not super creative science, audacious sciences - Ethical concerns: Project ownership, data ownership, behaviroual influence: grow crop a instead of crop b

Examples of citizen science:

- Papers in pnas
- 1000 gärten project
- INCREASE project

Describe biases in citizen science: Sampling bias, socio-ecological bias

- Check this article: https://besjournals.onlinelibrary.wiley.com/doi/10.1002/pan3.10592

7 Traditional knowledge

- not designed by a scientiest
- no control organisation or body
- “Methods knowledge”: Not only a knowledge about the taxonomy of crops, but also how to utilize them
- Is there a systematic alignment of traditional knowledge and the scientific description, e.g., the healing effects of some plants, or of certain land race varieties (lithium in certain quinoa varieties -> does it have an effect and can it be shown). Is a measurement by a Western scientist sufficient to have a measurable effect on health, for example. “significantly increased” vs. sufficient effect size?

8 Summary

In this lesson, a broad overview of the relationship between science and the public was provided.

- There is a strong relationship between the level of financial investment in science and the outcome.
- Scientists produce a diversity of tangible output, but the general public gets to know only a very small proportion of the scientific output.
- There are different communication channels of scientists with the general public whose limitations in presenting information correctly need to be considered.
- Negative reporting that uses fear, uncertainty and doubt is frequently used in critical communication about science because it is easy to raise fear about scientific developments and therefore prevent the adoption of new technologies.

9 Keywords

To be added

10 Further reading

To be added

11 Study questions

1. Why is the interaction of scientists with the general public important?
2. What are direct and indirect outputs of science that are relevant for the general public?
3. What are the transformations that scientific evidence experiences on its way to the general public?
4. What are key challenges in the communication of scientists of scientists with the public with respect to the correct communication of facts and scientific results?
5. What are the dilemmata of scientists in their communication with the public?
6. Which measures and programs have been taken to improve the communication of scientific results with the general public?
7. What are strategies of interested parties in distorting scientific evidece in the communication with the public?

12 In class discussion

12.1 TED Talk by Pamela Ronald

Pamela Ronald is a leading plant geneticist at the University of California, Davis. She is married to an organic farmer and together with him she wrote the book Tomorrows Table - Organic Farming, Genetics, and the Future of Food, Oxford University Press (2018) (Ronald and Adamchak, 2018).

We discuss the following questions in class:

1. What is her motivation to talk about her topic?
2. What is the key message of her talk?
3. Does present the critical points (risks vs. benefits) in a balanced manner?
4. Does she appropriately and convincingly present individual research success stories to make the general point that genetic engineering is a useful breeding technique?
5. Does she also make an ethical argument? Do you think it is appropriate?

References

Eisen M. 2016. The villain of CRISPR.
King DA. 2004. The scientific impact of nations. *Nature* **430**:311–316. doi:10.1038/430311a
Ronald PC, Adamchak RW. 2018. Tomorrow's table: Organic farming, genetics, and the future of food, 2nd ed. Oxford University Press.