International Union of Soil Sciences

Publish or Perish (3) – Fraud and ethics

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Better the world should perish than that I or any other human being should believe a lie ... that is the religion of thought, in whose scorching flames the dross of the world is being burnt away.
Bertrand Russell (1872-1970)

1. Introduction

The famous Dutch writer Gerard van het Reve once said that he was unquestionably a very evil and pestilential person. Not surprisingly, he added, as most human beings have a wicked nature. He believed that half of the depravity was inborn and the other half by human's own choice. Much of what van het Reve wrote was bordering on nonsense written in a brilliant way, but in my darker moments or when reading a newspaper, I sometimes tend to think that his observation is about right. Most people are good but some people are bad, and very few are very bad. History has learned that even the most decent and civilised person can become evil under extreme circumstances. There is no reason to believe that scientists are an exception.

I bring this up to discuss an important and sensitive issue: scientific fraud. Several cases have been reported and discussed in the past years in *Nature*. In order to get an appreciation of the size of the discussion, it is interesting to note that in 1999 *Nature* published nearly as much on fraud as on soil science. I thought it would be of interest to summarise some of the findings, and then discuss fraud and research ethics in soil science, which has received virtually no attention. This article is not an extensive review on fraud and research ethics but largely a summary of what *Nature* has published on the subject, supplemented with the opinion and experience of a number of soil science journal editors.

2. Scientific fraud

Although various obscure cases of scientific fraud were unearthed in the past like for example "Abderhalden's enzymes" (1920s), the "Piltdown man" (1930s), and "Cold nuclear fusion" (1980s), it was not until the late 1980s that scientific fraud or research misconduct received public attention. It was noted that "….*Nature* was presented with the uncomfortable need to decide whether loose use of language, or inadequate experimental data, are consequences of authors' haste or some more sinister concealment of the whole truth. This does not happen often, but that it should happen at all is a serious matter, requiring the cultivation by referees an all other concerned, of an over-suspicious mind." (Maddox, 1989). At the same time, scientific fraud received widely attention in the USA and many thought initially that it was a query about the frequency of misdeeds (Guenin,

1999). Much of the early discussion on fraud was focused on a definition and what was to be included.

My Webster's dating from 1996 gives the following definition: "Deceit or trickery perpetrated for profit or to gain some unfair or dishonest advantage" but also: "something that is not what it pretends". Grosso modo such definition is clear but borderline cases forces a more unequivocal definition. Currently, the following is used: FFP, meaning Fabrication (or the construction of data and matching up of results), Falsification (manipulating, changing or omitting data in order to represent the results) and Plagiarism (appropriating another's work without credit) (Powledge, 1999). Guenin (1999) further distinguished misrepresentation (deliver false utterance or omitting material), plagiarism (intentional presentation of the words of another as the presenter's own), and misuse of another's work (intentional presentation as the presenter's own without attribution of the ideas or work of another).

Examples of Fabrication

Several examples of fabrication and falsification have been reported in the last few years. Europe's worst case of scientific fraud dates from 1997 when the infamous Friedhelm Herrmann and Marion Brach stand accused of fabrication of data in more than 40 peer-reviewed publications over many years (Abbott, 1999). They were researchers in cancer and, amongst others, fabricated autoradiograms. Both were instantly dismissed from their institutes. Another interesting recent example is the "Petrol from plants" claim made by a 30-year-old self-taught chemist (Jayaraman, 1996). The chemist claimed to be able to power a scooter using "petrol" produced by adding leaves and bark extracts from a native herb to tap water. The set-up was cleverly done but in the end it appeared that his results were not reproducible. Scientific fraud not only occurs at universities and research centres but also in large public companies. For example, in 1998 the multinational Novartis dismissed a cancer researcher because of manipulating preclinical results (Schiermeier, 1998).

An overview of interesting cases on fabrication and falsification in science can be found on the homepage of Bernard Hiller:

http://home.t-online.de/home/Bernhard.Hiller/home-eng.htm (in German and English) which now also includes Walter W. Stewart's web site on scientific misconduct. These sites are worth a visit and both mention that .."scientific fraud is not minor and not under control". Most reported cases of fraud have come from the biomedical sciences.

Plagiarism and authorship

Plagiarism is an important form of research misconduct and in its clearest form it comprises the copying of text without acknowledging the source. A recent example was reported whereby Scottish physicists were caught having copied 50% of a paper by someone from the University of Heidelberg. Several explanations were made ranging from denial to forgetting references but after some time the fraudsters apologised and mentioned that it was an accident, that there was no intent to plagiarise and they had better things to do than plagiarise. The fraudsters further added that if every article in the medical literature was checked, plagiarism would be found all over the place (Dalton, 1999). Another form of plagiarism is the theft of ideas and this could for example occur in the review process of manuscripts or project proposals. It is hard to prove.

Authorship problems include misrepresentation of authors or leaving authors which have nonetheless contributed to a piece of research or a manuscript, or listing an author who is not aware of that, for example to "upgrade" the appearance of the manuscript. That is also a form of plagiarism and fraud.

I think we all know examples whereby department heads are automatically author on any paper – not for what they have authored but for what they are: institutional tycoons. It used to be worse. Until the 1960s or so it was very common that university professors would publish the research results from their students - usually these publications did not even carry the name of the students. At least that was the case at some universities in the Netherlands, but at the 16th WCSS in Montpellier I was told by a colleague that her supervisor published part of her Master's thesis without her knowledge and without acknowledging it. That occurred in the mid 1990s.

Recent reports have shown that authorship is a problematic issue for American and European young scientists (Tarnow, 1999). In Europe more than two-thirds of the young scientists are not given full credit for their research achievements and a survey of 191 postdoctoral physicists in the USA revealed that senior scientists are frequently listed as authors of papers even though they have had little or no participation in the work (Tarnow, 1999). Seventy-five percent had never discussed authorship criteria with their supervisors and in about 10% of the papers the postdocs found that their supervisor should not have been listed as an author. In 33% of papers with authors in addition to the supervisor or postdoc, one or more of those authors should not have been listed (Tarnow, 1999).

Another form of plagiarism is dual publication of the same findings – easy to detect, fairly common but rarely punished. This is in essence self-plagiarism which some consider very unethical whereas other think that self-plagiarism can not be a form of fraud.

Overall, when looking at the cases of fraud published I could not unravel a geographic pattern and reports have come from all over the world. This, at least to me, suggests that evil is reasonably well distributed over the globe. There are, however, hardly any data on the total number of fraud cases. The USA National Science Foundations reports that it averages only three findings of misconduct per year or 0.01% of the total projects (Powledge, 1999), which suggests that scientists are mostly honest and that misconduct is uncommon. Others have argued that the publicised cases are merely the tip of an iceberg whereas some think that the question of how widespread scientific fraud is might be unanswerable (Abbott et al., 1999). Research publications are growing exponentially and growth is currently about 10% per year. Scientific misconduct and fraud are increasingly reported but it is not known whether fraud is growing faster than scientific output.

Causes for fraud

Many scientific scandals result from incompetence, poor methodology or the unexpected behaviour of equipment, but why might a researcher deliberately falsify results? (Berry, 1999). I guess it needs a bit of a wicked and lazy nature in combination with extreme circumstances like stiff competition for research funds, pressure to publish, the fight for recognition and the rushing into print. Outliers of data and the frustration in attempts to have a theory recognised (Berry, 1999) may be other factors encouraging swindling of research information. The fact that barriers between industrial and academic research diminish (Finn, 1999) which may cause conflict of interest between funding agency and researcher, or ethical tension that arises from private research funding in public institutions (Rees, 1999) could also cause scientific fraud. Institutional circumstances which favour fraud are a strong hierarchical structure whereby the boss can get away with things, and extreme competition forcing the feeble-minded scientists to fraudulent practises. At last, many experiments cannot be repeated because of lack of funds so that results cannot be verified. Fraudulent authors know this.

Despite the various examples of scientific fraud little has been published about the driving forces. Mostly fraudulent scientists disappear and will not seek publicity. What drove an

extremely successful scientist like Friedhelm Herrmann to fabricate and falsify in more than 40 peer-reviewed publications? According to Abbott (1999), it was due to the "web of sex, violence and intrigue" that bound Marion Brach to her mentor, scientific collaborator and lover Friedhelm Herrmann. A fascinating explanation. Brach confessed fraud ("…an achievement of which I am not proud") but Herrmann continues to deny. In the good old days fraudsters, however bizarre their excuses, always admitted their guild when overwhelmed by evidence, but their modern counterparts usually obey their lawyers advice to deny it to the bitter end (Abbott, 1999).

Harm done by fraud

Sound science is about the best possible way to answer a given question; to present with rigour the certainties and uncertainties of knowledge, and the assumptions underlying certain conclusions (Haerlin and Parr, 1999). Public trust is based on sound science, and therefore even rare instances of misconduct shatter public confidence in science (Powledge, 1999). Adverse publicity may harm budgets, employment opportunities, and careers. But there is more. All honest scientists are victims of scientists who commit misconduct for the fraudster occupies a working place of a honest scientist (Arst, 2000). Fraud also obstructs progress, or in other words: Real progress originates from the refusal to take a path that would threaten one's own moral choices and values (Sternheimer, 1999). Sometimes it takes very long and much research money before fraud is uncovered. For example, it was only in 1998 that an US University has stopped the "cold-fusion" patents because "..there has been no progress in duplicating the original research .. and we decided it was not appropriate to spend any more public funds on this" (Nadis, 1998). By that time about $500,000 had been spent in pursuing the technology.

Scientific fraud resembles financial fraud in that it can bring undeserved remuneration and power, a salient difference being that in scientific fraud the ill gotten gains are automatically institutionally laundered (Arst, 2000). Another difference is that financial fraudsters are usually still employable whereas those who have committed scientific fraud may have to start looking for another profession.

Fraud detection

There has been a reasonable degree of apathy towards scientific fraud. As recently as 1997 the heads of UK research councils decided that misconduct is a lesser evil than the encumbrance of any mechanism to prevent it (Arst, 2000). They have changed their minds and have now published policies on misconduct. Although there are no mechanisms for ensuring compliance and institutions can whitewash misconduct or sweep it under the carpet, which is tempting since investigations bring adverse publicity (Arst, 2000). The America Statistical Association has embraced a set of ethical guidelines for statistical practices whereas the White House Office of Science and Technology Policy (OSTP) has recently finished a draft policy on federal rules on misconduct in scientific research (Powledge, 1999). The policy has emerged from more than two decades of mostly bitter struggle with the distasteful realities of scientific chicanery (Powledge, 1999).

The detection of most fraud cases reported in the literature was done by colleagues, and such people are usually referred to as "whistleblowers". Some institutions have an often anonymous committee in place for such activities (similar to sexual harassment committees) but fears for retaliation may hamper the work of whistleblowers. A committee investigating scientific fraud should protect both the whistleblower and the accused scientist. Sometimes protection is impossible as was experienced at the University of Giessen where a young veterinary scientist stripped of his PhD, has been charged with trying to kill his whistle-blower by spiking his tea with digitoxin (Abbott, 1999) – very

poisonous and fortunately not the type of chemical present in every soil lab. The whistleblower was taken to the hospital and treated in the intensive care whereas the accused scientist works as a veterinarian in a private practice – appealing the refusal of his thesis and denying the charge of attempted murder (Anon., 1999a).

The WWW

The internet is transforming the world of scientific journals (see *The Economist* of 13th May 2000) but peer review, essentially aiming to differentiate the sense from the nonsense, will remain. Plagiarism will be easier to detect with electronic publishing but falsifying and fabricating data will be impossible to eradicate. Although the WWW will speed the flow of valuable information around the world, a negative side effect is the increased exposure of students and the public to misleading or biased science, or to opinion masquerading science (Allen et al., 1999), like for example to the exploiters of creationism.

The web is also potential source of fraud and this may start with student theses. There are websites where students can download essays (e.g. http://schoolsucks.com, http://EZWrite.com or http://cheater.com), like for example "Food scarcity in India due to over population", This essay costs $59.40 and apparently there are students happily paying that amount if it will pull them through the exams. In return, plagiarism search engines have been developed which check whether a paper has been copied from the internet (e.g. www.plagiarism.org and www.canexus.com/eve). Such searches are not free of charge of course: fraud and fraud detection is business. A psychopharmacologist checked the papers of 320 students in a neurobiology class at Berkeley and found that 15% of the students had plagiarised material (Dalton, 1999). Students were warned beforehand that their work would be checked for plagiarism. It remained unclear whether they were actually encouraged to plagiarise or that they continued to do so after they were warned (Dalton, 1999).

I have done a quick search but could not locate any website advertising or selling soil science essays. They may exist or be developed (following publication of this paper), and in future lecturers and professors may have to use plagiarism search engines to check the originality of submitted essays for there is no reason to believe that soil science students are more honest than those studying neurobiology.

3. Ethics

There is a wide discussion on ethics in agricultural research like for example on genetically modified crops, animal cloning or animal welfare. A small part of this discussion focuses on ethics regarding scientific fraud which essentially deal with the rules of the game of doing science, which every player is forced to obey if he or she is to stay on field (Ziman, 1999). In summary: face up the demands of peer review, cite generously and meticulously, reward originality and priority of discovery, present your work impersonally and exclude *ad hominem* jibes (Ziman, 1999).

Many scientists have argued that research ethics should be taught at the university (Finn, 1999). Other have argued that solid, reliable laboratory habits and supervision and mentoring are critical components to prevent misconduct (Meguid, 1999). At the World Conference of Science in Budapest in June 1999, science policymakers of Arab countries pledged that scientists should take an oath of ethics including a commitment to high ethical standards, rigorous quality control of research findings, open access to their knowledge, and public accountability (Anon., 1999b). Having an ethics code is one thing, enforcing it, quite another (Luellen, 1992). The European Association of Science Editors

(EASE) states that the mere existence of independent bodies dealing with scientific dishonesty have a strong preventive influence (Riis, 1994).

Unclear authorship may to lead to fraudulent practises. One of the ways dealing with it is to state clearly in a paper who has done what. Statements clearly allocating credit and responsibility for the research done can only help to promote the health of science (White, 1999). Journals like *The Lancet* and *Nature* sometimes do this, for example: "R.R. conceived the experiment, and together with A.H. and L.L. carried it out; C.B.D. designed and carried out the data analysis; R.R. and C.B.D. co-wrote the paper" (Romo et al., 1999). A proposal of standards for such listings and other useful references can be found at: http://www.councilscienceeditors.org

EASE advocates that publication ethics involves the author, editor, the referee and the owner, whereby each has rights to expect and duties to fulfil (Riis, 1994). I will briefly summarise the EASE guidelines: "The author has an obligation to have gathered and interpreted his or her interventional or observational data in an honest way. After submission to a journal, the editor has the right to assume that the received manuscript does not contain fictitious data, deleted disturbing material, plagiarised material, biased citations or reference omissions, false priority statements, hidden multiple publications of the same data, or incorrect authorship. The author has the right to expect the manuscript to be treated as confidential material so that points of views or ideas are not, even indirectly, mentioned outside the editorial office. The author has the right to expect fairness from the editor, including unbiased selection of referees, because it is well known that an editor can kill a manuscript by selecting envious and critical reviewers from competing research groups." The reverse is also imaginable: 'old boys" networks whereby referees or co-authors are not critical enough – for example when they are the author's friend, or lover.

"The editor's possibilities for discovering scientific misconduct are less than most authors and readers believe, but if an editor's suspicion of scientific misconduct is raised, by whistle-blowing for example, he has the moral obligation to raise the matter with the author. Editor's duties comprise: competence, fairness, discretion, speed and politeness. The referee is the most invisible figure in the editorial process although there is a tendency towards greater openness. Referees are often anonymous and therefore present an ethical problem, especially seen with the author's eyes. The expectations of authors and editors of referees are: competence, fairness, confidentiality, speed and politeness. A major requirement is obviously fairness, because a referee may imitate an experiment and publish in parallel, or steal ideas. The reader has the right to expect reliable and adequate information from journal. The owner may be the publisher or a society has the right to expect that the editor runs the journal in a way that attracts and keep readers. The owner has a strong ethical obligation to respect editorial freedom, which means that control of editorial decisions is unacceptable. Lack of editorial freedom is probably one of the surest means of destroying a good journal, according to EASE (Riis, 1994)." The same applies to fraud.

SOME GUIDELINES

The web may be a source of fraud at the same time it is a major source of information on research and publication ethics. *Nature* (4th March 1999) published the following list of websites with details on good scientific practice or guidelines for handling, allegations of scientific misconduct:
US Office of Research Integrity: http://ori.dhhs.gov/regguide.htm
UK Medical Research Council: www.mrc.ac.uk/mis-con.pdf
UK Biotechnology and Biological Sciences Research Council:
www.bbsrc.ac.uk/opennet/structur/hrg/sciconco.htm
Germany's Max Planck Society: www.mpg.de/fehlengl.htm
Deutsche Forschungsgemeinschaft: www.dfg.de/aktuell/self_regulation.htm
Danish Committee on Scientific Dishonesty: http://www.forsk.dk/eng/cvk/index.htm
Other sites of interest: http://dmoz.org/Science/Science_in_Society/Research_Ethics and useful information about authorship and credit is given in: http://www.nap.edu/readingroom/books/obas

4. Fraud in soil science?

To my knowledge there are no written and formal reports about fraud in the reporting of soil research. It could be that in soil science it may be more difficult to distinguish deliberate fraud from honest errors in the interpretation of the results and mistakes in recording readings. It could also be due to the following adage which was sent to me by Dennis Greenland: "A scientist always distrust his results, but firmly believes his theories; other trust his results, but disbelieve his theories." Besides a matter of trust there are other reasons why fraud is not so likely to occur in soil science. Most of our research is not "hot" enough - this as opposed to much of the research on public health or research on genetically modified crops or for commercial interesting patents. Thus fabrication and falsifying data is not so likely to occur in soil science. The only exception I can think of is in environmental soil science, like the evaluation of contaminated soils of a potential building site. Overall it seems that soil science simply yields too little fame and money to swindle.

On the other hand there are reasons why fraud could be occurring and increasing in soil science. There is an increased pressure to publish and this could cause lazy, wicked and foolish authors to falsify data and rush into print. An example is given in Figure 1, whereby awkward outliers in graphs could be weeded out in order to generate a better fit. In most cases, researchers know their data and hence could appraise the outliers (sample contamination, lab error etc). An increasing number of researchers work with large data sets which they have not collected themselves. Therefore, they may not have sufficient knowledge about the limitations of the data set or make assumptions about the data set which are intrinsically false. The opposite may also be the case whereby authors work with a small data set trying to fit a relation but have to deal with awkward outliers hindering the potential for publication of their research.

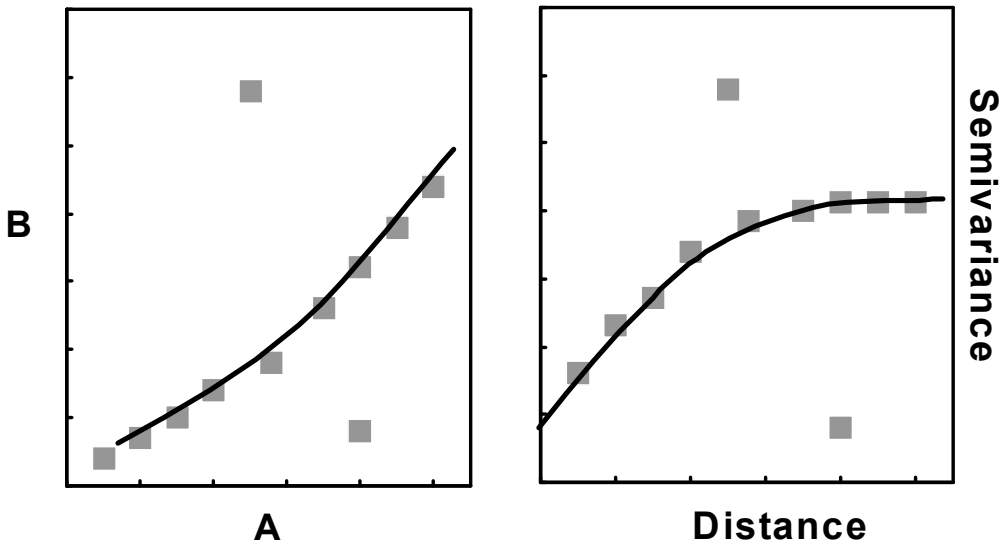

Fig. 1. *Those awkward outliers!*

There may also be political or commercial reasons to falsify graphs and figures. In many soil science subdisciplines funding opportunities are reduced (Mermut and Eswaran, 1997). Some soil scientists might be exaggerating the outcome of their research in order to secure funding because donors would probably be more impressed by a negative message than by a message casting doubts and uncertainties. In the long term, however, a biased message might perform a serious backlash and would do more harm than good, particularly as donors (although short-memoried) may show 'disaster-fatigue'. This was already pointed out by the former ISSS Secretary General, Dr Wim Sombroek, at the 13th Congress in Hamburg where he noted: "There is a temptation to bend the final results of a research project towards those that were stated to be expected at the start; it may lead to 'trimming, cooking and forging' of the results. The way things go now, one may be prostituting soil science and adulterating development aid! Soil research has political dimensions, yes, but ethical behaviour should not be different in soil science from that in other sciences, just because it so down-to-earth." A true word.

What others think and found

I have asked 23 editors from international soil science journals if they had experience with fraud. Not everyone replied and there were two editors who did not want to have their name and examples of fraud quoted, but here are the reactions:

Dr Bryan Davies, editor of *Soil Use and Management* (SUM), thinks that SUM may have been a victim of fraud based on the strong pressure to publish that scientists are under in some countries. This leads to authors splitting their projects between several papers with overlap between them, and also to premature papers written before sufficient information has been acquired. Dr Davies comes across such papers commonly and thinks it is only one further step for data to be deliberately 'strengthened'. Apart from editor's and referee's being vigilant and aware, Dr Davies sees no easy way of identifying fraud in the very 'impure' science of applied soil science. In addition, he thinks that approaches for identifying fraud will be useful to maintain the vital concept of scientific integrity.

Dr Alex McBratney, joint editor-in-chief of Geoderma wrote me the following: "Scientists, even soil scientists, are human and as such are prey to all the foibles of the

human condition. Fraud is a realisation of one of the seven deadly sins caused perhaps by others such as pride or avarice. I think it is important to distinguish fraud – a definite intent to deceive – from bad scientific practice often a result of inexperience or the current pressure to publish. In terms of fraud, I think the mildest form I see, but see quite often, is taking material from one paper and putting it in another without due reference. I think this happens when a new line of research is being opened up. The transfer often happens from one continent to another. I also believe that ex-officio authors – names appearing on papers by virtue of one's position, i.e., without having contributed anything, and names appearing without consulting the particular author are fraudulent, and I believe this occurs. As far as fabrication of data or definite exclusion of aberrant points I know of no concrete cases. It would seem logical that this would be more likely for small data sets where each observation has a high leverage on any models fitted or conclusions drawn. I am not sure whether publishing the same material in more than one journal is fraud, but I certainly think it is bad practice. The main kind of bad practice I see is lack of knowledge and citation of the literature – it is incumbent on us as scientists to know and show the material that has been published in our various disciplines. I think fraud can only possibly be a tiny problem in soil science, bad scientific practice is a much bigger one, but by far the biggest problem we have, is a lack of new ideas."

Dr Martin Carter, joint editor-in-chief of *Soil & Tillage Research*, and *Agriculture Ecosystems and Environment* has no experience with direct or full-scale fraud, only borderline cases. His main concern is plagiarism, especially in the description of methods. In some cases it may have been innocent copying of methods or approaches to methodology, but in a few cases authors have copied verbatim large portions of text without indicating 1) source and/or 2) without using quotes. Perhaps they consider because it is not 'data', it can be copied. Dr Carter have detected only a few cases of the above. However, in each case it was only by chance that he managed to detect it, and expects that it could be more widespread. In each case he has brought the concern to the author and requested that they provide a reference, use quotations, or rewrite the text in their own words.

Dr Mirek Kutilek, joint editor-in-chief of *Soil and Tillage Research*, commented the following" "It is difficult to distinguish what is fraud and what is an error. I have seen papers with an unbelievable lack of dispersion of measured soil data in field experiments where sampling was realised over a certain area and heterogeneity could be expected. Did the author "correct" or falsify the measured data? Was he or she aware of an improper measuring procedure and thus trying to "improve" the results? Or, did he or she measure at one location only and fabricated data for other localities? In several instances there were research papers where water content of a non-swelling soil was substantially higher than porosity, cumulative surface run-off by tens of percents higher than the cumulative rain, sum of exchangeable cations exceeding the CEC. Were some of those data fabricated, or were the analytical methods wrong? There is another act against scientific ethics: It happens quite frequently that instead of quoting the original author(s) who have introduced a certain method or new theory, the citation is on the second author who has actually copied the method, or used the theory and this runs further and further on principle of chain-quoting."

Dr John Waid, editor-in-chief of *Soil Biology and Biochemistry*, cannot recall any instance of fraud in soil science. The ex-officio editor of *Agroforestry Systems*, Dr Pedro Sanchez, has not come across a case of fraud in soil science. He finds that there are many articles published which omit important references and previous work which he considers an issue of quality of publication including the quality of the peer reviewers but not one of fraud.

Dr Richard Webster, editor of the *European Journal of Soil Science* (EJSS), has not come across fraud in his experience as editor. However, he thinks that 'dual publishing' is getting worse as authors are submitting virtually the same papers to more than one journal almost simultaneously. When this is identified it is written firmly to the authors pointing out the error of their ways and their paper is rejected. The EJSS does not compromise, for dual publishing is unethical when done without permission from publishers and contrary to the international law of copyright, according to Dr R Webster.

One of the joint editors-in-chief of *Catena*, Dr Mike Singer, is not aware of any cases of fraud that has been published. They have had a couple of cases among graduate students in his 27 years at Davis (California) where data have looked suspicious and experiments have been rerun under closer supervision. Plagiarism among students is something of a problem, especially among students for whom English is not their first language. This is usually easily corrected by discussing the problem with the student and cautioning them against repeated offences, according to Dr Singer. His colleague Dr Mike Thomas, has no recent fraud to report, either from his editorial experience or from the three soil scientists in his department. He added that some fraud may be 'hidden' and has worries about:

- duplication and fragmentation of results to achieve a greater number of papers than is justified by the data - common and difficult to police
- data sets lacking verifying information - such as careful specification of location and sample sites; also lack of replicates and attention to errors
- laziness in referencing, leading to lack of acknowledgement of source concepts, and comparable findings already published
- laziness in refereeing - most referees are conscientious, but some are not; very often these are well established scientists, who appear too preoccupied to give full attention to this essential task

Dr John Catt, of *Catena* and previous with *SUM*, has not come across any examples in his editing work - lots of incompetent writing but no fraud. He suspects soil scientists are more honest than the medics. Dr Olav Slaymaker also of *Catena,* wrote that he is not personally aware of fraud in soil science in the sense of fabrication or falsification of data. He added: "However, plagiarism is not an infrequent problem. Given that one is unlikely to recognise more than 10% of such cases, and given that I have caught several, this may well be the most serious problem (or at least the most widespread) that we have. My response has always been to return the manuscript and indicate unwillingness to take a second look or to send it out to other reviewers."

Dr Warren Dick, editor of the *Journal of Environmental Quality* (JEQ) and editor-in-chief of the *Soil Science Society of America Journal* has come across plagiarism or sending to two journals of essentially the same paper which happens about one or two times per year cases per year. A letter is written informing the potential author what they have found, that the actions are unethical and that the authors must withdraw their paper. They have not had to do any follow up or unpleasant responses. The approach does not really punish in any way, but does alert the offender that the actions are not appropriate for a professional scientist, according to Dr Dick. He further added that they probably do not catch all incidences of fraud.

The editor of *Nutrient Cycling in Agroecosystems,* Dr Paul Vlek, mentioned that blatant fraud was never proven in submitted manuscripts. Occasionally he has strong doubts and generally these papers are eliminated from consideration due to other problems. Overall, it is difficult to prove fraud in soil science as we rarely can reconfigure the circumstances of the experiments, according to Dr Vlek.

The editor of *Soil Science*, Dr Robert Tate, made the following comments "I have encountered incidences of plagiarism and we had to adjudicate a situation where an author had published essentially the same paper in two separate journals. Also, I have encountered several instances where manuscripts with many identical portions were submitted to *Soil Science* plus another soils journal. These were detected during the review process and dealt with. Similarly, I have had a couple of instances where referees have noted that their work had been plagiarized in the manuscript under review. In all cases, a) the author was reprimanded, b) the manuscript in question was rejected, and c) where the intent to "fraudulently publish" was clear, the author was banned from submitting material to our journal. In situations where other journals were involved I worked with the editors of the other journal to ensure that the decisions were consistent and fair to all involved. Fortunately, such occurrences are rare. I would estimate that over 15 years in the capacity of editor, I have probably encountered about half a dozen such situations."

Ms Jenny Fegent, managing editor of the *Australian Journal of Soil Research*, wrote to me the following: "I have not come across fraud in soil science. I have encountered dishonesty in the form of concurrent submission to two (or more) journals and have dealt with it by rejection."

At last, at the editorial offices of Elsevier Science in Amsterdam five to ten cases per year occur whereby authors are unaware that their names are listed on a paper. The offices handle about 6,500 manuscripts for 40 journals, and they have not come across papers with fabricated data.

Summarising these observations it seems that multiple submissions and dual publication are the main problem. A number of editors mentioned that they have had experiences with falsification of data and they consider this more serious and asked me not to mention those cases for they may be recognised, or as someone said: "They were a long time ago. The people concerned have learned their lesson and are now respected members of the international scientific community." I have been talking and e-mailing to various colleagues and there are more of such paleo-fraud cases in soil science. There may be no reason to unearth all those but there are very good reasons to have fraud avoided – if it can be detected.

How to detect fraud in soil science?

There is a major role for colleagues, research collaborators and assistants to detect the fabrication and publishing of fraudulent data. There is also a role for reviewers and editors to detect dubious papers although peer-review procedures did not develop to detect fraud or even, originally, to establish the standards and authority of science (Burnham, 1992). Most editors have a difficult time detecting fabrication and falsification but allegations of plagiarism has come to attention several times (Meguid, 1999). Some journals asks authors to sign a declaration of scientific integrity in their letter of transmittal (Meguid, 1999). As far as I know, none of the agronomic or soil science journals has such a policy. Directly after submitting a manuscript to *Plant and Soil*, a form has to be signed in which the corresponding author declares, amongst others, that any person named co-author of the contribution is aware of the fact that and has agreed to being so named. I think that is a good initiative to which perhaps may be added "…and declares that the work is free of falsification and fabrication of any kind".

All journals require a copyright form to be signed which is no guarantee that papers are also published in another journal as dual publication seems to occur in soil science. It is obvious bad and fraudulent practice but to some extent I can understand authors neglecting copyright laws: not the publisher but the authors should be in the

position to determine what can be done with their published work. However, with the signing of the copyright form authors agree upon the copyright laws. *Lex dura sed lex.*

6. Conclusions

One cannot be a little bit pregnant. Pregnancy is a very definite although somewhat temporary status. Nor can one be a little corrupt. The same applies to scientific fraud. It is small in science and probably even smaller in soil science, but we need to be alert for fraud publicity destroys individual careers and harms the prestige of institutes and may also put soil science in a negative daylight. In the current situation of limited funding - despite the favourable economic conditions in many countries - such news would be undesirable. The brief survey of the experiences of various journal editors has shown that fraud is not absent in soil science. Therefore it deserves wider attention, and perhaps the formulation of guidelines on research ethics in soil science by a committee of the IUSS.

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