

Presidential address

Fuelled by Science and Tempered by Experience

Laurie COPLAND

Corresponding author: laurie.copland @xtra.co.nz

In 2018, at the Twizel Conference our President, Graham Kerr, in his Address, said he “joined the (NZGA) Executive, to support science and objective thinking.” He also said “science is under fire, as never before. It is misquoted, misused and misunderstood.”

Over my 45 years as a farmer, I’ve witnessed movements in farming that are supposedly better than conventional farming. Permaculture, Organic, Biodynamic and more recently Regenerative. Whether these are better depends on definitions. For me, I’m a conventional farmer, which by my definition means using science.

It’s not just in agriculture. In this age of the internet there are sources of information that can be unreliable, some in society are promoting ideas and thoughts that they believe are supported by scientific facts that are in fact not. This has been highlighted recently with theories around covid and vaccines. I believe these beliefs are influenced by a lack of understanding of what science is and how it works.

So, what is Science? What is this Science that fuels us? When did you last ask yourself this? Have a think about it, what is your elevator pitch to describe what science is.

I’m going to give my perspective from thinking about this over a good part of my lifetime. The first time, I remember, was when I was in a science class at high school in the late 1960’s. The discussion went along the lines of science is the process of the “scientific methodology” the charts of which lined the walls of the science rooms. In simple terms it is observation, hypothesis, test (experiment), get results that lead back to observation.

However, to my dissatisfaction, it was pointed out that some science doesn’t follow this method. Biologist sometimes just make observations, as do astronomers. Einstein used mathematics as models and carried out thought experiments. Watson and Crick got a Nobel prize from making a model of DNA. Admittedly they used science of others to validate it, like Wilkens, the New Zealander, who also received the Noble prize for this. There is nothing more scientific than getting a Nobel prize.

So, so far, we haven’t a precise definition. Even so the scientific method has led to the scientific revolution that started in the 17th century, that modern society has benefitted from.

Thinking about this topic I realised this could just become a literature search. I knew there are sections in Libraries on the philosophy of science written by better minds than my own. I don’t have time in this address to give it justice. To illustrate the complexity of the topic is this diagram that appeared on a Face book post just as I started this writing this address. I’m not competent enough to verify this diagram.

However, latter in this address, I am going to quote from a couple of books of a number I have read over the last decade on the period of enlightenment. When I have difficulty solving a problem, I look at it from a different angle. “What is science?” is the wrong question. We know science works, the progress that society has made even in my lifetime hasn’t happened by chance. The question should be “how does science work?”

While studying for a science degree I took a social science paper. What struck me, was how hard it was for the social sciences to be scientific. In the science department we just got on with it. The question of being scientific wasn’t really discussed it was self-evident. The social science paper did however introduce me superficially to the thoughts of Karl Popper and Thomas Kuhn on science. Karl Popper lived from 1902-1994 was a Philosopher and spent the WW2 years in NZ from 1937-1946. In the book of “The Logic of Scientific Discovery” (1959) he proposed the concept of falsifiability to distinguish between science and non-science. Any number of positive outcomes will not confirm a theory but only one negative outcome shows the theory to be false. The theory must be able to be proven wrong to be science. An example of falsifiability given is the statement “all Swans are white” observing a swan or many swans that are white does not conclusively prove the statement true, but it takes only one observation of a black swan to falsify the statement.

The advancement of scientific knowledge is an evolutionary process as competing theories are shown to be false leaving only those that haven’t been¹. Scientific methodology has been a key component of this process. But I know this is not enough. There’s more to science than this.

Thomas Kuhn lived from 1922 to 1996 and popularised the term “paradigm” and “paradigm shift”. *“Men whose research is based on shared paradigms are committed to the same rules and standards for scientific*

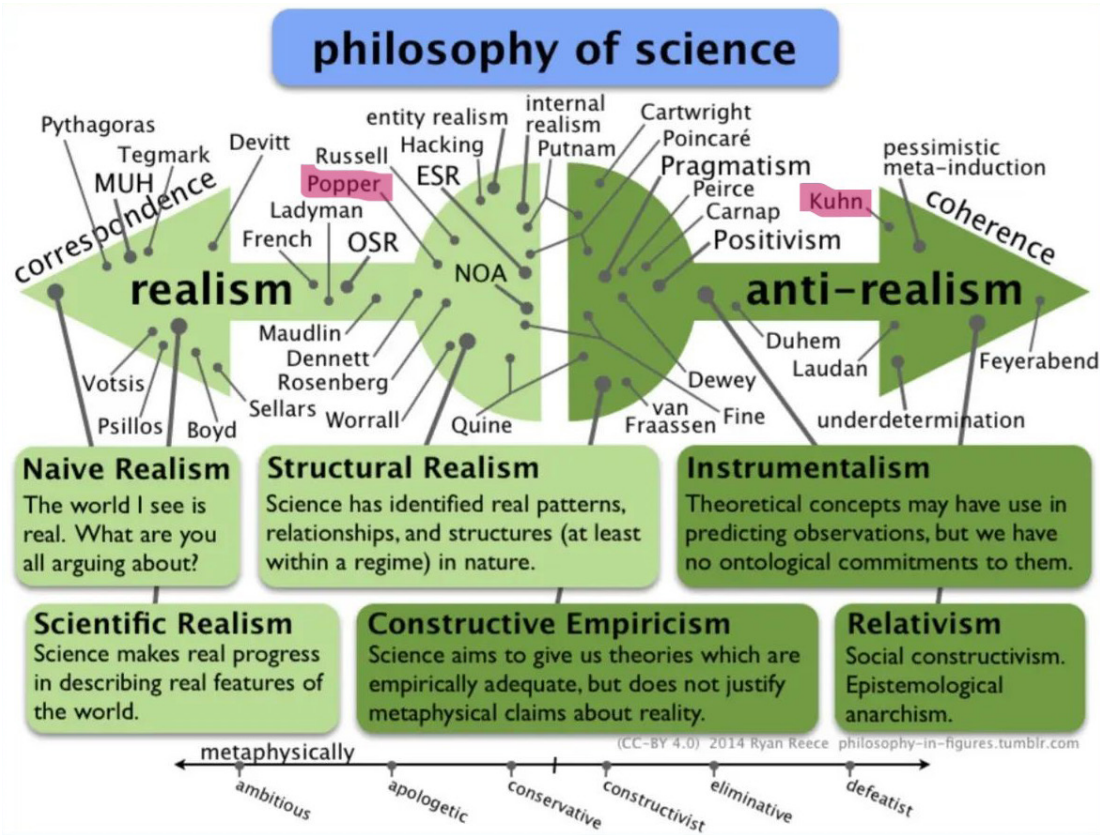


Figure 1 (CC-BY 4.0) 2014-2017 Ryan Reece philosophy-in-figures.tumblr.com

practise. That commitment and apparent consensus it produces are prerequisites for normal science...” (Kuhn 2012). And “To be accepted as a paradigm, a theory must be better than its competitors, but it need not, and it in fact never does, explain all the facts with which it can be confronted”.

His paradigm is not just the scientific concept but includes the language used in common, the sharing of information, and science education. Those in a field of science use words that outsiders may not know. How many of the public know what ME is? Yet those in agriculture science know what it means and understand the science behind it. They were educated at some stage what it stands for, accept the units of measure and may have seen the papers that explain its relationship with animal growth and production. This helps explain the success of science. It is progressive. It means once a paradigm is accepted it is free from constantly needing to re-examine its first principles (Kuhn 2012).

In last year’s Presidential address Warren King, said we in agriscience “stood on the shoulders of giants of the past”. This is true, but we also learn from the small

contributors as well. We build a wealth of knowledge that reinforces the paradigm.

A paradigm shift happens when a new scientific theory results in a shifting of how the world is viewed. The old theory has problems explaining observations in the real world. Newtons equations could not predict the orbit of Mercury (the Mercury paradox) and we moved from a Newtonian paradigm to the one of Einsteins General relativity which could. Another example of a paradigm shift is when it is accepted by all members of the NZGA that kikuyu is a great grass species!

The importance of shared units of measurement and other science concepts is demonstrated in the book “The measure of all things” (Alder 2002). This is the story of two French astronomers, Delambre and Mechain, who started measuring the meridian arc of the Earth from Barcelona (Spain) to Dunkirk (Northern France) which passed through Paris and they started in 1792. They wished to use this as a way to establish the unit of the meter. One ten millionth of distance from North Pole to Equator, although in fact it’s not quite.

The importance of standardised units not only helps

the progress of science but economies. Britain at that time had started the industrial revolution, they had national units of weights and measures while prior to the French Revolution, the French had not, and had 250,000 different units.

The other theme of the book was error. This was a time before statistics. Discrepancy of data was viewed as a personal failure. God's world was perfect, so imperfection was not acceptable. Now statistics is taught as part of the scientific process that gives confidence in results using probabilities. The trouble is the general layman wants 100% certainty which science doesn't give.

In another book "The Calculus Wars" (Bardi 2006), is the story of Leibniz and Newton both of whom developed calculus in the 1600's. What struck me in this book is the names of other scientists that were known to each other and Newton. Boyle, Hooke Halley and others. Scientists don't work in isolation, they discuss ideas. After Newton helped Halley with the maths of the orbits, Halley encouraged Newton to write "Principia" and Halley paid for its publishing. Earlier Newton had sent his paper on Optics to the Royal Society 1672. This paper contradicted Hooke's views on the nature of light and Hooke got to review Newton's work. The criticism hurt Newton and he didn't present his mathematics papers on calculus until decades later.

This brings us to replication of work. Newton was annoyed at the criticism of his Optics paper when he had done the experiments. Presenting a paper should enable another to repeat the work to verify the results. This is the concept of Trust but Verify, a Russian proverb. This was made famous by Ronald Reagan, US President in dealing with The USSR in nuclear disarmament. Work should be reproducible. In an article of *The Economist* (2016), reports from a drug company when it attempted "to reproduce the results of 53 high profile cancer research papers; they found that only six lived up to their original claims." These results were published in *Nature* (2012).

This is what the peer review process of papers is designed to help eliminate. Having peers in the field of the researcher looking at the paper to make sure that the experiment is robust and repeatable. The peer review should also ensure that the results have the proper interpretation. No matter what every scientist says no-one is purely objective, but they can design their experiments to reduce any lack of objectivity. Having a peer review is part of this process of being objective.

Help is on the way, with AI being used to go through all papers in a field to not only find outlier results but suggest new areas of research. Again, *The Economist* (2023), had the headline on the front cover "How AI

can revolutionise Science." So, I'm looking forward to the first paper based on AI to be presented to the NZGA conference.

Conclusion

Science is more than making predictions that can be falsified by either direct observation or by the objective scientific method. It is a process to progress knowledge. So far as I can see science is science, it's not Western science nor any other science. You can give it another name but its either science or its not science.

The NZGA is an important part of this scientific process. The NZGA encourages early career scientists and members. Sponsoring up to 10 students to our Conference and, along with the NZGT, sponsored 3 early career attendees to the International Grasslands Congress (Kentucky) this year. The NZGT also sponsors students with the Levy scholarship and has the David Scott award for young agricultural professionals.

The NZGA holds this Conference for scientists to present their work, expanding the knowledge and ideas plus network with fellow scientist and the wider agribusiness community. The NZGA publishes the *Journal of NZ Grassland* with peer reviewed agricultural science papers. This is available on-line and as at September 2023, was having paper viewings of around 3600 per month.

However, there is a long-term declining trend for membership of the NZGA. So, if you're not a member of the NZGA, consider becoming one. If a colleague isn't one, ask them to consider becoming one. If you haven't presented a paper in our journal or have not done so for some time, consider doing so. If you're asked to review a paper, please do it, because others are reviewing yours.

As a farmer and as President of the NZGA I obviously value the contribution that the NZGA has made getting the science for me to use on my farm. So finally, if you have an elevator pitch of what is science? I'd like to hear it.

References

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