Good science to fuel the future

Dr Charlie Reinhardt, a botanist from the University of Pretoria, says the challenge of global food security can only be addressed with sound scientific research and development.

"It is common knowledge that a second doubling in food production will be needed to feed the world's population by 2030. Yet it is becoming increasingly difficult to increase crop yields appreciably towards the elusive 'genetic potential ceiling'.

So what can we do to increase food production significantly in a relatively short time in this hot, crowded and hungry world? In short, we should support sound scientific endeavour, and trust this science as practised by scientists of proven ability.

WHAT TO TRUST?

Scientific research outputs worthy of the name 'good science' are invariably published in peer-reviewed scientific journals. Scientists are competitive animals and will not allow false scientific outputs to go unchallenged. Sooner rather than later, the truth will come out.

Good science is currently pitted in a 'war' against poor and even false scientific communication. In his article "The War on Science: The Age of Disbelief" (*National Geographic*, March 2015). *Washington Post* science writer, Joel Achenbach said that the Internet had "democratised information", which was a positive development.

At the same time, however, he warns that "along with cable TV, it has made it possible to live in a 'filter bubble' that lets in only the information with which you already agree".

Let us therefore remain cautious in our appraisal of new technologies, and at the same time put our trust in proper scientific method, or else trust in people using the scientific method properly.

PROPER SCIENCE IN AGRICULTURE

Ultimately, the more science we put into agriculture, the more successful, profitable and safer it will be. Generating knowledge about the cultivation of crops is science, not merely because the word 'science' stems from the Latin word *scientia* (to know), but by dint of the method in which that knowledge has accrued.

Marcia McNutt, editor of the prestigious journal, *Science*, says that "science is not a body of facts – science is a method for deciding whether what we choose to believe has a basis in the laws of nature or not".

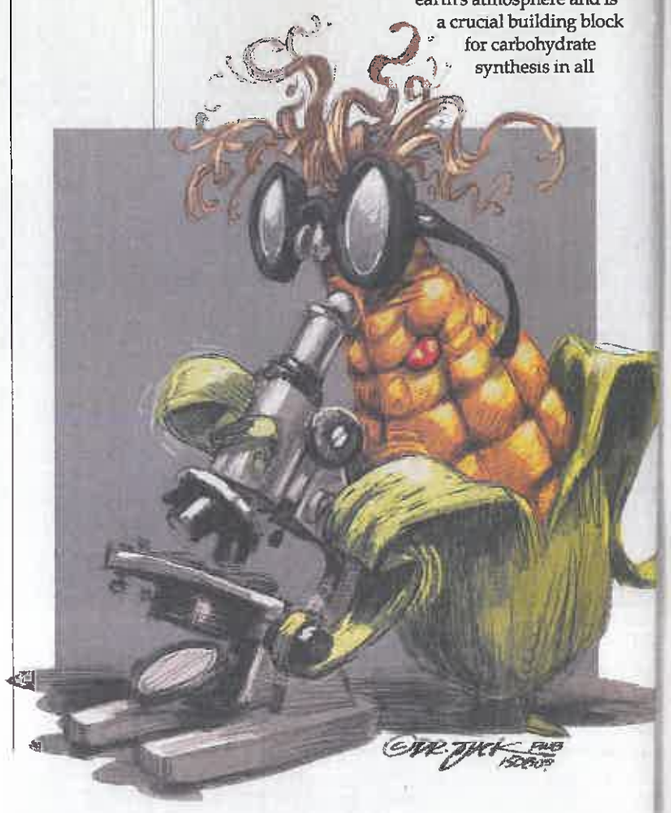
In a nutshell, the scientific method comprises the testing of a hypothesis (question) through experimentation, followed by subjection of the data generated in experiments (results) to statistical analysis.

About 10 000 years ago, when people first domesticated plants with the aim of cultivating them, plant and technology improvement was an ongoing process. But this development took place so slowly that people of a single generation were unlikely to see major changes in crops or cultivation practices. Even marginal improvements are likely to have taken several generations to be realised. Perhaps we underestimate the speed with which knowledge accrued in these times, but certainly progress in agriculture did not depend on science in the modern sense of the word.

THE STEADY MARCH OF SCIENCE

Modern media have promoted the impression that science forges ahead through dramatic discoveries by eccentric geniuses. The truth, according to Achenbach, is that "[science] usually advances incrementally, through the steady accretion of data and insights gathered by many people over many years".

Today, the world is abuzz with real and imaginary threats that are nearly impossible to separate without rigorous scientific investigation. Scepticism in people's minds about scientific findings, however true these might be, is understandable, given the extent to which they can stretch the imagination. For example, how can a simple gas like carbon dioxide (CO_2), which makes up less than 0,1 of 1% of the earth's atmosphere and is a crucial building block for carbohydrate synthesis in all green plants, be associated with climate change?



A recent survey by the Pew Research Centre showed that only 40% of Americans accept that human activity is the major cause of global warming, despite overwhelming scientific evidence that it is a major contributing factor to rising 'greenhouse' gases.

MILESTONES

The past century has seen many other revolutionary achievements in agronomy. Henry Ford introduced the Fordson, a gasoline powered tractor, in 1917, and by the 1920s tractors with gasoline-powered internal combustion engines were in huge demand. Associated technology was the three-point hitch "the simplest and the only statically determinate way of joining two bodies in engineering".

MOST IMPORTANT INDUSTRIAL PROCESS

The Haber process employed by Carl Bosch of BASF in 1913 made it possible for the first time to harness atmospheric nitrogen (N_2) by fixing it as ammonia (NH_3). This achievement has been hailed by some as the most important industrial process of the 20th century.

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All these developments were backed up by exhaustive scientific experimentation in the field of engineering. This was boosted by intensive financing, design and manufacture associated with tank production in the First World War.

Closely associated with the Second World War was the development of the first selective herbicides. The auxin-type (plant-hormonal action) herbicides 2,4-D and MCPA were developed before 1945 in the US and the UK respectively for controlling broadleaf weeds in small grains and maize. These herbicides revolutionised weed control at the time, and they remain popular and useful to this day. Products containing 2,4-D and MCPA are relatively cheap, and weeds are far less prone to developing resistance to them than to many other more modern herbicides. Since then, other selective herbicides have come on the market. These herbicides are a remarkable achievement given that weeds and crops are both plants. It is only rigorous research by thousands of scientists over decades that could have developed a chemical capable of protecting a crop and killing a weed.

The atmosphere's most abundant compound could now be turned into synthetic fertilisers such as urea and ammonium nitrate. This took crop production to levels previously considered impossible, allowing billions of people to be fed.

Subsequently, genetically modified (GM) crops, in particular transgenic Roundup Ready® (RR) crops tolerant to the herbicide glyphosate, have revolutionised global crop production. Yet ever since 1996, when RR crops were first introduced, there has been vociferous objection to biotechnology for building transgenic crops and the associated herbicide, glyphosate. In effect, a war has been waged against GM crop technology, despite voluminous scientific evidence that neither technology has lasting toxic effects on humans, fauna, flora or the environment. Moreover, they ensure profitable crop production wherever they are used around the world.

Crops that offer greater water- and nutrient-efficiency will provide further benefits for farmers and consumers, and here too, public acceptance of good science will help to speed adoption of this technology.

NO TIME TO LOSE

Quantum leaps in synthetic pesticide (insecticides and fungicides) and fertiliser development, classical crop breeding and farm implements all played a role in the 'Green Revolution', which saw yields in maize, rice and wheat doubling from the mid-1950s to the mid-1990s. However, the green revolution had its greatest impact in Asia. The technologies largely bypassed sub-Saharan Africa and crop production per capita has actually declined here in recent decades.

For Africa, there is no time to lose, and those technologies that have their inception in sound science should be embraced.

• *Dr Charlie Reinhardt is extraordinary professor of weed science in the Department of Plant Production and Soil Science at the University of Pretoria, and dean of the Villa Academy. Phone him on 083 442 3427, email dr.charlie.reinhardt@gmail.com, or visit http://goo.gl/5vh4N7.* FW

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