Are we on the verge of a fourth agricultural revolution?

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In this insightful analysis, Professor Guillaume Blanchet from Université de Sherbrooke examines whether we are on the verge of a fourth agricultural revolution and explores new technologies for agroecology

The first agricultural revolution is considered to have occurred sometime ten to twelve thousand years ago when humans transitioned from being hunters and gatherers to settlements focused on agriculture. The second agricultural revolution was between the 17th and 19th centuries when new technologies (such as crop rotation, drainage and plough) were developed, significantly increasing yield and productivity.

As for the third agricultural revolution, it can be traced back to Ronald A. Fisher (born in 1890; died in 1962). Fisher is considered the father of modern statistics and has shown how genetics can be used to apply the theory of evolution in practice.

Many of the developments Fisher made, which are still commonly used today, were made studying agricultural systems during his time at the Rothamsted Experimental Station (now known as the Institute of Arable Crops Research) in England, where he analyzed crop experimental data gathered between the 1840s and the mid-1930s when he left the research station.

The third agricultural revolution explained

What is interesting about the third agricultural revolution is that it assumes crops are grown in a controlled environment. Farmers try to prevent the crops from interacting with other organisms as much as possible. To put it differently, the general idea behind this agricultural revolution is that we can get better yields if we remove the influence of other organisms.

Using some of the idea proposed by Fisher, agriculture developed into monoculture, that is, large areas cultivated with a single crop. The typical representation of monocultures are the corn or wheat fields in the plains of Ukraine or Canada that go as far as the eye can see. This way of working, combined with developing disease-resistant crops, is at the heart of the third agricultural revolution.

Norman Borlaug was a key figure in this revolution because the agricultural practices he proposed dramatically increased crop yield, and as they have been broadly implemented, they are considered to have saved a billion lives by preventing starvation. In 1970, Borlaug received the Nobel Peace Prize for his work. Combined, the work of Fisher and Borlaug has made agriculture what it is today.

However, in the past few decades, we have discovered the limits of some of the practices proposed in the third agricultural revolution. In particular, regarding chemical pesticides and fertilizers, which have been and are still commonly used to increase yield. Even if pesticides are quite efficient, pests have adapted and become more resistant to them. Initially, the solution used by farmers to prevent the degradation of their crops by these resistant pests was to increase the quantity and concentration of the chemicals used to save their crops.

However, when we eat this food, we also eat some pesticides used to protect and grow the crops. So, although these practices are good for growing crops, the large quantity and concentration of pesticides used to get high yields have been shown to be bad for human health.

Controlling pests and soil quality without using chemicals

Currently, drones are being used to assess the particularity of fields and for some crops, such as vineyards, even individual plants are monitored. Vast amounts of data are being gathered with the sole goal of generating more and better crops. These data are typically used to make recommendations to reduce and adjust the amount of pesticide and fertilizer to apply. This is definitely a step in the right direction for environmental and human health, but, ultimately, we should aim to stop using chemical pesticides and fertilizers.

An alternative that has become more popular during the past few decades is agroecology, which proposes using the knowledge gained in ecology to grow crops without pesticides, making them better and safer. Many approaches are used in agroecology, so pesticides are not used. For example, multiple crops are planted instead of planting a single crop in a field. By carefully choosing the crops that are combined, we can better control pests and soil quality without using chemicals.

New technologies for agroecology, including AI

Agroecology is showing a lot of potential. It is better for the environment as it increases biodiversity in agricultural areas and is less impactful on climate in part because the greenhouse gases that are created to make pesticide and fertilizers simply do not need to be produced. Furthermore, agroecology is also beneficial for humans socially and health-wise.

However, because agroecology is much more labour intensive, it is typically performed at a much finer scale and, as such, it is not always as sustainable economically. That being said, new technologies are changing this trend. Notably, advanced statistical modelling and artificial intelligence (AI) are bringing new insights into managing agroecological systems more efficiently.

There is hope that, in the next few years, radical changes will be seen in how agriculture is being done. There are strong movements across the public, private and academic sectors to take a more ecological perspective when working in agriculture. In essence,

there is an increased realization that agriculture should account for all the living things surrounding the crops we grow, a task intimately linked to ecology.

To achieve this goal with the precision and scale required in agriculture, advanced modelling tools such as the ones proposed by computational statistics and AI must be used. The combination of advanced modelling and ecology in agriculture will result in a completely novel way of producing crops. It is what may launch the fourth agricultural revolution.

There is an opportunity that nations can take to become leaders in this field, but political will and investments are required. Many nations are investing massively in AI, but few are considering ecology and agriculture at the same scale. Yet they should.

We should never forget that agriculture feeds most humans on Earth, and ecology focuses on understanding how life works, allowing us to better understand how to improve our knowledge of agriculture. Only through leadership and investment in ecology, agriculture and AI will we be able to continue feeding the constantly increasing world population.

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