

Facing changes today for an agriculture tomorrow

Alexandre Brice Cazenave

University of Burgundy, France

Correspondence: Alexandre Brice Cazenave, University of Burgundy, Dijon, France, Email abricecazenave@gmail.com

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Editorial

The origins of agriculture can be found around 100,000 years ago while it is assumed by researchers that our ancestors were eating fruits, nuts, and roots before that period. However, around 105,000 years ago, the first signs of seeds collection and consumptions by humans were observed in Africa, eating starchy, cereal-based snacks¹. More recently, traces of a sedentary camp were found in Israel, dating from 23,000 years ago, with about 140 plant species and evidence of food preparation based on wheat and barley.²⁻³ In China, rice was domesticated around 8,000-13,500 years ago as it was shown using molecular evidence.⁴ In the middle age, agriculture was transformed in Europe but not only, by improved agricultural techniques as well as the diffusion of crops which introduces species such as sugar, rice, cotton, and fruit trees to Europe from Arabian countries.⁵ After 1472, exchanges between the New World and the Old World through the “Colombian Exchange” brought new crop species in both parts of the Atlantic Ocean, developing a bit further agriculture.

Through the centuries, domestication of plants and more generally agricultural practices required the development of techniques to increase yield, and therefore, commerce, and exchanges. Irrigation processes, crop rotation, and even fertilizers started to be used by our ancestors. Early on, the fertilizers were manure- or nutrient-based as soil fertility was one of the main interest of farmers (Egyptians, Romans, Babylonians) for thousands of years.⁶ In the 19th century, work using different types of manures was conducted to test their effects on plants growing in pots, and later in the field resulting in the creation of the first artificial manure industry in 1942. Later, new studies witnessed the development of processes enabling the transformation of methane and dinitrogen into ammonia and then into nitric acid. The first synthetic fertilizer was created and today, fifty percent of the world population is fed because of synthetic nitrogen-based fertilizers.⁷

If the use of fertilizers was well understood to increase crop yield, it resulted into the development of other types of fertilizers, phosphate-based, or using sulfur-coated urea as the sulfur would be a nutrient of interest. However, the increase of fertilizer use has to be also linked to the population which has to be fed. It is a sort of vicious circle. To increase yield and get enough crop for human food and animal feed, there is a need of using more fertilizers. The population continues to grow so the need for more fertilizers increases and so on. Between 10,000 and 5,000 years ago, the world population was carefully

estimated to 4-5 million individuals.⁸ From -5,000 BC to the year 0, the world population has increased up to 170 million individuals, an increase of more than 34 times in 5,000 years, to finally reach about 7 billion currently, so another increase of 41 percent in 2,000 more years. The exponential increase in the population continues and tends toward 9 billion by 2050, 11 billion by the end of the century.⁹ Some fertilizer sources, such as the phosphate, would become limited by then as they are non-renewable. There is, therefore, more improvement to be done to become independent of fertilizers before the yield becomes a limitation, inducing people starvation. Besides the increasing population, we are facing also an aging population, helped by better health systems, and cures.

In parallel, a greater population, an evolution of the cultures, the continuous development of new systems brought ideas to increase yield. Since 1900, mostly in the developed countries, and in a less extent in the developing countries, productivities were increased by the development of mechanistic tools, production systems which came to help humans, and sometime, to replace humans. The harvests and more generally the farm workload became faster, less painful for the body. Producers are using more and more chemicals. Different from the fertilizers, as they are not made to increase yield, they are developed to protect the existing one and avoid loss from pests and diseases. However, these pesticides, insecticides, fungicides bring also questions about the impacts on plants. Often, research, such as in Kuznetsov et al.¹⁰, are made to test any secondary effects of these specific molecules on crops, on humans, or on animals, besides the original impacts they were originally developed for, before being considered for commercialization.

This modern agriculture is raising a lot of questions and political concerns. For example, a great amount of fertilizers is used while crops uptake only a small amount, the rest remaining into the soil conducting to eutrophication and dead zones where life cannot develop.¹¹ To produce more without using too many fertilizers, or to obtain tolerant crop species to environmental changes we are facing (increasing temperature, drought) or diseases, genetically modified organisms (GMO) are developed. However, these GMO are not allowed everywhere, some nations requesting more tests, longer tests, raising more questions about the GMO and their secondary effects than the ones they answer. Selective breeding seems to be a tool increasingly used by research organizations all over the

world to develop individuals having traits of interest in a particular environment, resulting in more efficient species. These species would hopefully be able to grow more with less, but moreover, to grow in the conditions of the future.

There is a crucial need to increase research, funds, and collaborations towards this work. We have to bridge the gap existing between the different thematic and areas of expertise as not one alone would be the answer by itself, but only a part of it. And this is the work which can be the answer to the today's problems, for an agriculture tomorrow.

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