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Agriculture

Bertrand Valiorgue[1]

Abstract. This article investigates the impact of the Anthropocene on agriculture. If agriculture is usually accused of emitting greenhouse gas and reducing biodiversity we show that agriculture might be seen as the first victim of the Anthropocene. This article shows the different negative impacts of the Anthropocene on agriculture and questions the future of this fundamental activity at the basis of the human civilization.

Agriculture is the basis of all human societies. Since its invention over 10,000 years ago, this essential activity has undergone continuous transformations that accelerated in the second half of the 20th century. Agriculture is the basis of three essential activities for the maintenance of human physiology and civilization: food, drug (through herbal medicinal products) and clothes (through animal and plant textile fibres). Many authors have noted the coincidence between the entry into the geological era of the Holocene (12,000 years ago), the development of agriculture and the blossoming of human civilization (Hamilton, Bonneuil, & Gemenne, 2015). The stable and temperate climate that established with the Holocene allowed the development of an important biodiversity that humans gradually domesticated in order to meet their basic needs. It was the geological era of the Holocene that allowed human civilization to develop because it made agriculture possible. The entry into the Anthropocene fundamentally shakes up this favorable situation for agriculture as it is massively and negatively affected by the ongoing transformations of the Earth system. These impacts occur at several complementary levels.

Transformation of hygrometry. Animals and plants have vital water requirements in order to be able to develop. The presence of abundant water is a characteristic of certain regions of the terrestrial globe which is brought to evolve with the changeover in the Anthropocene. These regions, which are accustomed to rainfall and in which we logically find a large part of the agricultural areas, will have to deal with water scarcity. Rarefaction which will considerably complicate agricultural activity when it is not simply going to compromise it. This water scarcity will lead to conflicts of use around a resource that has become increasingly scarce and that some will want to appropriate in order to continue its activities (Hoekstra, 2019).

Heat and biological cycles. Plants need access to light and certain temperatures in order to develop and grow. The absence of light and too low temperatures are prohibitive. Conversely, overexposure to light and excessively high temperatures are also particularly harmful. The plants mobilized by agricultural activity, and in particular the four main food crops (wheat, corn, rice, soybeans), need a temperate climate and a certain threshold of exposure to light (Lobell, Schlenker , & Costa-Roberts, 2011). Outside of this spectrum, farming is simply not feasible. The increased heat is redistributing the cards in agricultural production around the world. Underprivileged regions will have to stop farming, hitherto privileged regions will experience drop in yields and new production areas will emerge (Dar & Laxmipathi Gowda, 2013). Finally, heat peaks are particularly difficult to manage for farm animals which are parked inside buildings which are transformed into ovens. Without an adaptation of these buildings and / or a change in practices, we must expect significant production drops and peaks in mortality during heatwave periods (Lengnick, 2015).

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Extreme weather phenomena and agricultural disasters. For Anthropocene specialists, the climate will be marked by an increase in the frequency of occurrence of extreme events such as storms, droughts, heat waves, floods (Bonneuil & Fressoz, 2016; McGuire, 2013). When they arise, these events destroy the plantations and wipe out a whole year of work. The regions that will be hit by these events will simply be deprived of crops and will have to meet their food needs by drawing on other production areas. Tensions and volatility on prices are expected given the more frequent occurrence of these extreme events. They will also considerably weaken the economic models of farms because they involve loss of income which is very difficult to compensate for and to ensure (Raffray, 2019). The volatility of the Anthropocene climate will directly reflect on the financial markets, which will be nervous, fluctuating and deeply destabilizing. An abnormal drought in Russia can generate a rise in the price of cereals which will result in famine in Africa.

Atmospheric change and nutritional value. In addition to disrupting the biological cycle of plants, the Anthropocene also affects the nutritional value of agricultural products such as cereals and potatoes. Indeed, an increase in the CO2 content in the atmosphere results in a decrease in the protein content of cereals which lose part of their nutritional value. In the absence of new plant varieties, it will therefore be necessary to produce more cereals in order to generate the same protein intake (Lobell, Schlenker, & Costa-Roberts, 2011). This transformation of the intrinsic quality of plants will also impact industrial chains upstream of agricultural production. Companies in the agri-food sector have indeed calibrated processing tools according to certain nutritional values of agricultural raw materials. This drop in nutritional values will require adjustments to these tools and a potential increase in the cost of food items.

Loss of biodiversity. Agricultural activity is often accused of being the cause of biodiversity loss. In fact, it is the transformations of the Earth system that induce living conditions that are now inappropriate for certain plant and animal species (Pimm et al., 2014). This loss of biodiversity means a considerable depletion of the genetic resources that are the basis of agricultural activity. 75% of the world's food production is generated from twelve plant species and five animal species. The loss of biodiversity means that we are losing animal and plant alternatives that could beneficially replace the species that we have overexploited so far and that are adapted to the geological epoch of the Holocene. Legumes (peas, beans, lentils, peanuts) are, for example, underexploited plant species compared to cereals, although they have the capacity to store nitrogen in their roots and do not need additional inputs. Tubers (potatoes, yams, Jerusalem artichoke, tapioca, cassava) and roots (carrots, radish, rutabaga, turnip, celery) also have under-exploited nutritional potential.

On a more general level, the setting in motion of the Earth system shifts agriculture from a risky activity to an uncertain one.

Agriculture is a risky activity in the sense that when carrying out a biological cycle (animal or plant), it is normal to see a certain number of hazards emerge that will negatively impact the activity. The occurrence of illnesses, heat waves or even extreme events are among the risks of the profession. Farmers have learned to face and manage these risks. For example, they have developed in-depth knowledge regarding of plant and animal diseases. They have developed and learned to use care methods (pesticides, fungicides, herbicides, antibiotics, etc.). They have also developed a whole range of institutions which make it possible to smooth the effects of these risks (subsidies, market regulation, storage capacities) in order to limit the phenomena of food shortage. They also have developed insurance mechanisms that

guarantee income even if crops or animals have been destroyed by an extreme climatic event or an accident.

Everything changes with the arrival of the Anthropocene because agriculture (re) becomes a fundamentally uncertain activity.

The plants and animals that humans have taken thousands of years to domesticate are less and less adapted to the characteristics of the emerging Earth system. It means two things. On the one hand, the knowledge acquired to master the biological cycles of current plant and animal species is becoming increasingly obsolete because this knowledge is only valid under stable and known pedoclimatic conditions which are those of the Holocene. A new climate in fact means a new behavior of plants and animals, new pathologies and therefore new practices which must be invented, tested and learned. On the other hand, this new Earth system logically implies to be interested in new varieties of plants or animals more adapted to the new climate and which have not been or very little mobilized. It is therefore necessary to embark on the exploitation of plant and animal cycles, the characteristics of which farmers have little knowledge of. Knowledge of animal and plant species currently used is thus becoming less and less relevant and knowledge of animal and plant species more suited to the Anthropocene era is yet to be built. The Anthropocene creates a new context for agriculture that involves reviewing knowledge and forging new institutions (Valiorgue, 2020).

Short bio

Bertrand Valiorgue is Professor at EM Lyon business school and research associate at CLeRMa/Clermont Auvergne University. He has a PhD in management and work more specifically on sustainable issues in the agricultural sector. He is the author of several articles and books and notably *Refonder l'agriculture à l'heure de l'Anthropocène* (Le Bord de l'Eau, 2020).

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