High-tech agriculture or agroecology for tomorrow's agriculture?

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HARVARD COLLEGE REVIEW OF ENVIRONMENT & SOCIETY

ENGINEERING OUR FOOD

A DISCUSSION OF GENETICALLY MODIFIED CROPS

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HIGH-TECH AGRICULTURE OR AGROECOLOGY FOR TOMORROW'S AGRICULTURE?

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Sylvie Bonny is a research scientist at INRA (French National Institute for Agricultural Research). She works in agricultural economics, notably on techno-economic change in agriculture, such as the impact of GM crops.

Today high-tech agriculture (particularly biotechnology) and agroecology are often considered as opposed pathways. However, when one wishes to address the issues of food security, there is no technological panacea. High-tech agriculture and agroecology should not be so deeply opposed. Rather, they should be combined as much as possible. Agroecology is defined as "*the application of ecological concepts and principles to the design and management of sustainable food systems*" (Gliessman, 2007).

Consensus on the need for more sustainable agriculture, yet strong controversy over the right course to take

While many people call for sustainable agriculture and better nutrition or diet, very different answers are given, particularly to the issue of "how to sustainably feed the growing population in the next decades."

Among them, two main pathways can be roughly identified. The first is to increase agricultural and food production, mainly by the applications of science and technological advances to enhance production, efficiency, and better use of resources. This leads to recommending high-tech agriculture, especially involving biotech crops, new information technologies, precision farming, robots, and other techno-scientific advances.

The second is to implement ecological and grassroot technologies and practices, as well as participatory research, more local supply, diet change, etc. This leads to recommending agroecology including its practices, knowledge and social aspects. Agroecology "*is based on applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system*" (FAO, 2017).

These two pathways are frequently seen as opposed. Their respective supporters, proponents, and stakeholders are often different, and rather frequently in conflict. Usually the agricultural input industries, i.e. the farm machinery industry, the agro-chemical and seed industry, the feed industry, etc. put forward high-tech agriculture. It is considered as the best way to efficiently use inputs, manage costs, and respect the environment while being highly productive. This is presented as a way to increase production without requiring too much additional farmland or water.

At the same time some farmers' organizations and a certain number of scientists and organizations promote agroecology based on understanding and managing ecological processes and biological functions to increase and sustain agricultural productivity (FAO, 2015; Hatt et al., 2016). They put forward several aspects, such as (Valenzuela, 2016):
– the conservation of resources and the implementation of eco-efficient and integrated farming systems with few chemicals, particularly few chemical pesticides,
– the promotion of biodiversity: genetic diversity, species diversity as well as ecosystem diversity,
– a better management of physical and biological resources,
– the regeneration and maintenance of soil quality,
– the recycling of nutrients,
– the diversification of cropping systems, the association of crop and animal production, and also of trees and wild vegetation,
– landscape-wide management.

The points of view of scientists in the public research sector appear to be diverse. While a great part of scientists involved in plant breeding promote biotech, a certain number of scientists involved in agricultural sciences, ecology, or social sciences seem to be keener for agroecology. In each country the adopted policies of the Ministries of Agriculture also play a role, as well as the views of the public and cultural aspects. Some countries such as the USA appear to invest mainly in high-tech agriculture, while others such as some European countries tend in addition to favor agroecological approaches, at least in part. For example, in Europe many people are opposed to GMOs while in the USA in the last 20 years their general acceptance has been better: so, in 2015 the EU grew only 0.13 million hectares (Mha) of GM crops while the USA grew 71 Mha. By contrast there were 11 Mha of organic area in the EU and approximately 2.2 in the USA. However, research and development (R&D) expenditures geared to high-tech agriculture seem to be much higher than those to agroecology, especially since a growing part of agricultural R&D is made by the private sector (Fuglie, 2014). Even public research in agroecology is rather limited (DeLonge, 2016; UCS, 2016; Vanloqueren, Baret, 2009).

The term "agroecology" has three main dimensions: a scientific discipline, a social movement, and farming practices (Wezel et al., 2009). Here we focus mainly on the scientific aspects. However, some scientists and organizations, particularly some peasant organizations such as Via Campesina, also emphasize socio-political aspects of agroecology. "*Agroecology is not only about farming practices, it is a holistic approach that includes cultural diversity and social justice as important aims of our food and farming systems. Agroecology is a central pillar of food sovereignty, a global grassroots movement working to combat poverty, inequality and hunger (…). World hunger is caused primarily by poverty, lack of democracy and unequal access to land, water and other resources and infrastructure, especially among women. Rather than simply producing more food under unequal conditions, the solution to hunger hinges on creating more democratic and fair political and economic systems that expand access to resources" (FoEE, 2016).*

A strong controversy, but also some commonalities

High-tech agriculture also needs to take agroecological aspects into account to avoid ecological and social damage. The use of advanced technologies doesn't exempt one from following good agricultural practices such as crop rotations, crop diversification, and sustainable use of natural resources. High-tech agriculture also requires agroecological knowledge for the proper design and implementation of its technologies. For example, GM herbicide-tolerant crops should have been cultivated by taking into account rotations of herbicides and crops to avoid the development of herbicide-resistant weeds that have become a major issue in the last few years (Bonny, 2016). GM crops with single, double, even triple gene resistance to some insects are not sufficient: the durability of this genetic resistance requires proper management and an association with other practices in order to prevent a rapid loss of efficacy.

Besides, the applications of high technologies will not be able to ensure sustainable farming if they are not sustainably used and implemented. They need to be linked with good agricultural, economic, environmental, and socio-political practices. Furthermore, their accessibility, affordability, and conditions of use are essential.

Agroecology needs much techno-scientific knowledge, many scientific advances, and technological tools, in addition to local and farmer knowledge. Agroecology also requires very high knowledge, both tacit and practical as well as scientific and technological. The application of ecological principles to agricultural and food systems requires skills in agro-ecosystems, biodiversity, nutrition, etc.

For example, much research and experimentation are needed on intercropping, mixture of varieties, integrated pest management, biocontrol, nutrient recycling, soil enhancement techniques, biodiversity, agroforestry impacts, landscape design (with interactions between crops, hedges, wetlands, and semi-natural elements), diversification of farm production, etc. Much research is needed so that these practices can be adopted and be productive enough. Re-embedding agriculture in nature and relying much more on functional biodiversity and internal resources need a lot of research work, particularly if we take into account the challenges of climate change, population growth, and the loss of arable land due to encroachment of urban areas.

Therefore, both high-tech agriculture and agroecology are in need of scientific, technical, practical, and local knowledge. Both are knowledge intensive and need multidisciplinary approaches.

The governance of economic, social and environmental aspects is at stake

An important aspect of innovations is the governance of their context, i.e. their socioeconomic and sociopolitical environment, their affordability and conditions of access. These last aspects depend notably on the direction, implementation and regulation of innovations whether agroecological or high-tech. These characteristics mainly stem from the general governance of the agri-food sector. However, this governance doesn't depend predominantly on the agri-food sector itself, but mainly on the general governance of economic, social, and environmental issues.

Regarding food security, a high level of food production, whether globally or just in certain countries, is not sufficient per se to avoid food insecurity. One major reason of food insecurity is poverty, not the lack of food production globally. The four pillars of food security are the physical availability of food, the economic and physical access to food (notably its affordability), food utilization, and the stability of these three components (FAO, 2009). Therefore technological aspects are not sufficient; sociopolitical factors are also essential.

"Besides, the applications of high technologies will not be able to ensure sustainable farming if they are not sustainably used and implemented. They need to be linked with good agricultural, economic, environmental, and socio-political practices."

Thus, high-tech agriculture and agroecology should not be so deeply opposed, they should rather be combined as far as possible. However, this implies changes in their governance. For example, high-tech and biotechnology should not predominantly be in the hands of companies which are highly dependent on financial markets requiring high and very rapid profitability (which could not be the case in the agricultural sector). There should also be better communication between the scientific sector and the general public, to avoid reciprocal mistrust, or even rejection, as has been the case for GMOs in several countries.

Conclusion

High-tech agriculture should not hold agroecological principles and practices in contempt. Likewise, agroecology should not position itself as opposed to techno-scientific advances. Given the magnitude of the challenges that humanity is facing, there is no room for sterile opposition, or for reliance upon one single alternative, whether that is high-tech agriculture or agroecology

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