Toward Multipurpose Agriculture: Food, Fuels, Flex Crops, and Prospects for a Bioeconomy

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Abstract

Each day, agriculture becomes more highly integrated into an increasing number of industries. Agriculture has never been only about food; cotton, tobacco, and other non-food agricultural commodities (not to speak of spices and luxury foods, such as sugar and coffee) have for centuries been important to livelihoods and the economy. Yet, thanks to developments in biotechnology, the scope of agriculture is broadening quickly, and it may expand significantly in the coming years.

The biofuel boom of the late 2000s may have sparked something far more permanent than itself. Although many food crops had found multiple industrial uses before that time (e.g., sugarcane has always been used to produce not only sugar but also spirits; soybeans produce both protein meal and cooking oil; maize already enjoys a plethora of uses in the processed foods industry), the expansion of biofuels showed agro-industry that those uses could go well beyond food.

Climate change, the increasing pollution of marine and terrestrial ecosystems with fossil-based products (most notably plastic), and the finiteness of fossil resources have all highlighted the need to move away from such resources and seek biodegradable alternatives. Thus a rapidly growing niche of various biobased products (e.g., plastics, polymer composites, paints), in addition to biofuels, is poised to increasingly replace products now made from oil, thereby developing a so-called bioeconomy in many industrial sectors (IfBB 2016).

It often goes unsaid, however, that bioeconomy development means both sourcing a plethora of raw materials from agriculture to make products that were previously made from oil and linking that sector to myriad new downstream markets and actors. Such a transition, clearly, is not without important political, environmental, and socioeconomic implications. Although the global food system has already made it rather challenging to untangle supply chains

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and their associated impacts on food security or the environment, it is now poised to become even more complex.

This forum piece discusses an important debate around the political ecology and political economy dimensions of such a transition. First, I elaborate on the growing trend within agrifood systems toward multipurpose agriculture and present some of its key concepts. Second, I briefly discuss some of the already perceived and potential consequences this trend can entail. Finally, I raise critical issues worthy of further attention and research regarding power structures and the implications of such a transition on the global environmental politics of agriculture and food.

From "Flex Crops" to Biorefineries and the Bioeconomy

For millennia, many plants have had multiple uses. The same tree could provide fruit, therapeutic leaves or bark, and wood for construction; a traditional crop like rice would provide food but also plant material for housing, making utensils, paper, and so on. Industrial agriculture—with its typically linear, assembly-line structure—substantially altered that paradigm, replacing multiple uses and local circular economies with long chains linking specialized production to ever more distant consumers (Kneen 1995; Magdoff et al. 2000). Now, however, a new paradigm shift (bringing some old elements to the fore again) is under way.

An emerging debate on "flex crops" reveals how a small number of crops (particularly maize, soy, sugarcane, and oil palm) have been championed in their versatility and possibilities for meeting the demands of various downstream markets (Alonso-Fradejas et al. 2016; McKay et al. 2016; Oliveira and Schneider 2016). As Borras et al. (2016) point out, such flexibility has two complementary dimensions: multipleness and flexibleness. *Multipleness* means identifying and promoting different concurrent uses of the same crop, in the form of a variety of co-products and byproducts (e.g., soy cake for animal feed, soy protein for human foods, soy oil). *Flexibleness* is the capacity of producers to switch seamlessly from one use to another, based on given technological and economic conditions. They may choose which commodities to produce from their crops (e.g., sugarcane producers are able to switch back and forth between sugar and ethanol production, depending on sugar and gasoline prices, adjusting to whichever is more advantageous), as well as select among different downstream markets depending on which one is most attractive (palm oil, for instance, may be used for different food products as well as in the biofuel and cosmetic industries) (McKay et al. 2016). We may increasingly see, therefore, "crop-use change" in addition to land-use change (Borras et al. 2016).

The expansion of biofuels represents a great boon in this regard. Between 2000 and 2016, annual global biofuel production leaped sevenfold from 18 billion to 135 billion liters, using primarily well-established food crops, such as maize, sugarcane, and oil palm (Bastos Lima and Gupta 2013; REN21 2017). In Brazil, for instance, half of the cultivated sugarcane is used to produce ethanol rather than sugar, and most of sugarcane's market value comes from biofuel sales (McKay et al. 2016). It may be quite telling that Rubens Ometto, patriarch of a long-standing family of sugarcane barons and chairman of Brazil's largest sugarcane company (Cosan SA), joined *Forbes*' ranks as "the world's first ethanol billionaire" in 2011 thanks to biofuels. Even the beef industry, which one would hardly think of as being flexible regarding what it produces, became a significant provider of biodiesel feedstock (beef tallow) (Cremonez et al. 2015).

Global biofuel expansion may have recently decelerated, but production continues to grow. It is projected to increase by 16 percent between 2016 and 2022, again using primarily established agricultural commodities (International Energy Agency 2017). Despite recent policy support for electric or hybrid vehicles, biofuels may still develop as a stepping-stone technology and will probably remain significant in agriculturally strong countries such as the US and Brazil. In a globalized world, nevertheless, this geographical limitation will not prevent worldwide impacts (see Bastos Lima and Gupta 2014).

More economically significant in the longer run, however, is the expansion of various other biobased products. The bioplastics industry alone is expected to grow from meeting 1 percent of the demand for plastics to meeting 10 percent by 2030 if it continues to grow at the current rate (Higson and Aylott 2012). As environmental and political concerns around the use of oil increase along with the reach of biotechnological possibilities, the impetus for such bioeconomy development grows.

The "biorefinery" concept suggests industrially processing (i.e., refining) biomass to extract and separate its various (bio)chemical compounds (Langeveld et al. 2010). Energy in the form of biofuel is but one possible output, along with other bulk or commodity products of high volume and comparatively low value, such as industrial oils, adhesives, surfactants, solvents, and biopolymers for biodegradable fibers and plastics, in addition to low-volume, high-value products, such as chemicals for the food, cosmetics, and pharmaceutical industries. Clearly such developments offer a huge potential to provide renewable feedstocks to those industries, diversify agricultural sectors, and create development opportunities. Today, only a small share of oil is used for nonenergy purposes, yet its economic value is approximately equal to that of all the oil used as fuel (Aiking 2011; Langeveld et al. 2010). Conceivably, something similar may come to happen between food and such novel agricultural value chains.

The Sustainability of Multipurpose Agriculture and Biorefineries

A transition toward multipurpose agriculture and its integration into multiple value chains is not likely to take place without significant impacts—positive and negative—on people, the environment, and the global food system.

The development of new industry sectors and economies based on agriculture means, first, that increased demand for biofuels and other bioproducts provides a growing market and thus an incentive to cultivate particular feedstock crops. New value chains would become connected to the whole range of ecological and socioeconomic issues related to agriculture, such as impacts on soil and water quality and deforestation, but also to the creation of employment and income in rural areas. Second, the utilization of agricultural crops—or of resources like arable land and freshwater—for manufacturing biofuels or various bioproducts means that it competes directly or indirectly with food production, thus impacting food supplies, food market prices, and food security. Third, crop-based (bio)economic development means that actors, regions, countries, and even continents that have agriculture as a major economic activity can develop new industries, potentially become new energy or technology providers, and alter political power structures from the local level to the global level.

To date, most assessments of the sustainability of biorefineries have been limited to their technological and economic viability, at the expense of social equity or political issues (Palmeros Parada et al. 2017). This clearly stems from a "weak" take on ecological modernization, which often assumes a conflict-free, harmonious society without political interests or domination structures (Foster 2012; Pataki 2009; Neumayer 2003). This, however, means that important social inequalities could be reproduced or even aggravated under the guise of sustainability (Baker 2007).

As with other mainstream developments in the "greening" of agrifood systems (e.g., climate-smart agriculture), the creation of "green" crop-based value chains for bioeconomy development has so far promoted primarily capital-intensive solutions, making business entrepreneurs, industry actors, and dominant technology developers the main agents of change (see Baker 2007; Blühdorn 2011). This privileges wealthier actors and highly industrialized countries, which have greater capacity to invest in such "solutions" and thus minimize the need for sociocultural changes, such as ameliorating their disproportionate consumption patterns (Baker 2007; Blühdorn 2011). This approach also advances Western scientific rationality as the dominant knowledge system, along with its assumptions, prevailing norms, and related power structures (Pataki 2009).

Earlier experiences with "flex crops" have shown a number of trends that may be about to grow. Perhaps most important is the expansion of industrial monocultures of crops well suited to the bioeconomy, such as has happened with maize in North America, soy and sugarcane in South America, and oil palm in Southeast Asia and elsewhere. Having multiple and flexible uses strengthens producers' resilience, buffers them against shocks, and reduces market vulnerability. However, it also creates massive demand for such commodities, which leads their production to prevail over other farming systems; alternative cash crops; or nonagricultural land uses, such as forest conservation. In this context, the emerging integration of such industrial monocultures into novel value chains, such as bioplastics, is poised to give them even greater steam—in terms of market demand (and thus prices), policy incentives, political support, and public legitimacy—than what they would normally have if they were competing against other land uses or alternative agricultures "only" as food production. This means that any alternative project for agricultural development may also have to compete on such grounds and incorporate the potential for nonfood uses.

Furthermore, the expansion of such major crops has been accompanied by the spread of outgrower, contract-farming schemes of dubious social sustainability. Smallholders worldwide have increasingly replaced traditional mixed-farming activities (which have well-known challenges, including poor technical assistance, limited credit, poor market access, etc.) with monocultures to become contracted suppliers of those given crops (Wang et al. 2014). For instance, more than half of Indonesia's booming palm oil production takes place under this kind of arrangement (see Gatto et al. 2017). This accompanies a trend to integrate smallholders into global agriculture supply chains—frequently under a social inclusion and poverty alleviation discourse—even though, in some cases, it has resulted in smallholders ending up worse off in some ways (Bastos Lima 2012; Hickey and Du Toit 2007). Current research on the versatility of flex crops and their integration into novel downstream markets shows that benefits are primarily accrued by the agro-industries that control such chains via value-added stages and seldom by the farmers who grow the crops (Bastos Lima 2012; Gillon 2016; Turner et al. 2017).

Given the seeming inevitability of a global transition from fossil-based to biobased goods and economies, understanding how it can be navigated and steered toward sustainability is of paramount importance.

Navigating an Inevitable Transition

The global agrifood system has become increasingly complex over recent decades, a complexity that may be about to intensify even further as environmental concerns lead us away from fossil resources and toward more biobased economies. The issues that arose with the emergence of biofuels may have been but a glimpse of the controversies and intricate food–environment relations likely to emerge in the future. Biofuel may not be the ultimate renewable energy technology but rather a stepping-stone toward more advanced and efficient technologies in the future. Yet, even if, in the long run, crops and other biomass sources are no longer significant providers of fuel, they will likely still supply chemical components and raw materials for numerous bioproducts to replace those currently made from oil derivatives (e.g., plastics, solvents, lubricants). This is in tune with the present momentum to advance green economy industries. However, there is a clear need for more assessments of the sociopolitical dimensions of such emerging strategies, particularly for the various new agriculturally based bioeconomy value chains.

Presently, at least two important gaps remain. First, it remains to be seen how bioeconomy value chains may be governed. Experience to date with biofuels has shown that, although there are concerted governance efforts at the international level, a regime was never formed, and production continues unabated in a very liberal policy environment regardless of its global sustainability or food security impacts (Bastos Lima and Gupta 2013). Certification alone has been quite limited in ensuring the sustainability of agricultural and biofuel value chains (De Man and German 2017).

Second, it is clear that bioeconomy developments can either help address or aggravate current power imbalances in agricultural value chains. Greater flexibility in the use of crops and various agricultural commodities can enhance producers' resilience and reduce their vulnerability to market volatility, besides creating further demand, as highlighted earlier. On one hand, if such new bioeconomy developments become merely add-ons that further empower the existing agro-industrial complexes and expand selected monocultures, they will likely only increase their environmental footprint and the existing dominance of agritech corporations and developed countries. If, on the other hand, the 1 billion people worldwide whose livelihoods depend on agriculture would stand to benefit significantly from the technological and economic development spurred through such novel bioeconomy chains, this could offer a potent avenue for sustainable development. In this context, control of value-added processes seems particularly critical. Which policies and policy instruments may lead more effectively to one outcome or the other, however, is something that needs further research.

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