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Agriculture intensification: Bridging gaps between food security and biofuel production in Brazil

J.G.D.B. Leite*[1], M.R.L.V. Leal[2]

[1]University of Campinas, Brazil, [2]Brazilian Bioethanol Science and Technology Laboratory, Brazil

Introduction

Marked by the food crisis of 2008, when prices of basic commodities reached historic highs, many questions have been raised as to the future of global food security in the 21st century. Among the main drivers for the surge of food prices, biofuels feature as one of the most disputed subjects. Boosted by climate change and energy security concerns, liquid biofuels emerged as a renewable alternative to reduce GHG emissions through the substitution of finite fossil fuels and as an opportunity to increase rural income and agricultural investments. On the other hand, the allocation of arable land to the production of biofuel feedstocks raise questions as to its overall impact, particularly if large amounts of food products are diverted to biofuel production. Moreover, the production of some biofuels may be environmentally negative, particularly if associated with land use change-related deforestation. Therefore, what has emerged as a promising solution to climate change and fossil fuel dependency seems to gradually become a stumbling block on the path of global development. In this work, our objective is to question the basis for the enlarging disconnect between biofuels and food security. In order to gain useful insights, particularly in developing regions, we explore food security indicators together with crop and biofuel production, and land use dynamics in Brazil over the last 25 years. We argue that acute changes in the production systems (through intensification) may be key in order to achieve food security, environmental preservation and biofuel production.

Methods

Nowhere, among the developing nations, food security and biofuels have developed as in Brazil. Consistent increase in food production coupled with a significant participation of renewables in the energy matrix (≈46%), particularly from sugarcane (ethanol and electricity), are rather uncommon and, at the same time, high valued features if one wants to understand or gain knowledge on food security and biofuel dynamics. Our analysis is based on a detailed assessment of available food security indictors, which are discussed in parallel with the development of crop production, sugarcane ethanol, land use dynamics (i.e. pasture intensification) and deforestation in Brazil over the last three decades.

Results

Over the last 25 years, Brazilians experience a consistent increase in food uptake, particularly protein (Figure 1A). The same period was coupled with the stabilization of food prices and the reduction of price volatility (Figure 1B), which helped to boost food availability and stability. Moreover, from 1974 onwards food deficit, inadequacy and undernourishment, especially among children, decreased dramatically in Brazil (Figure 1CD) that, altogether, enabled the country to lift millions out of extreme poverty, reduce inequality and improve human development.

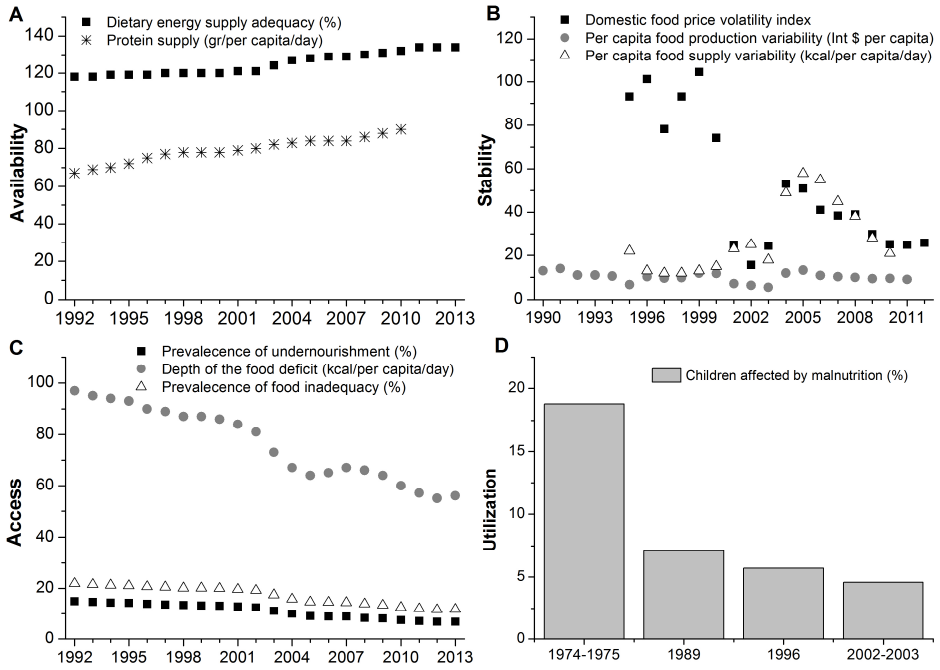

Figure 1. Food security indicators on availability (A), stability (B), access (C) and utilization (D) in Brazil. Source: FAO (2013) and IBGE (2010).

Food security improvements were tied to a remarkable agricultural development, which in roughly 30 years quadrupled food production with an increase of about 50% in the cultivated area (Figure 2A). Such development was only possible due to deep changes in how food is produced in the country. This process was characterized by the gradual transformation of extensive

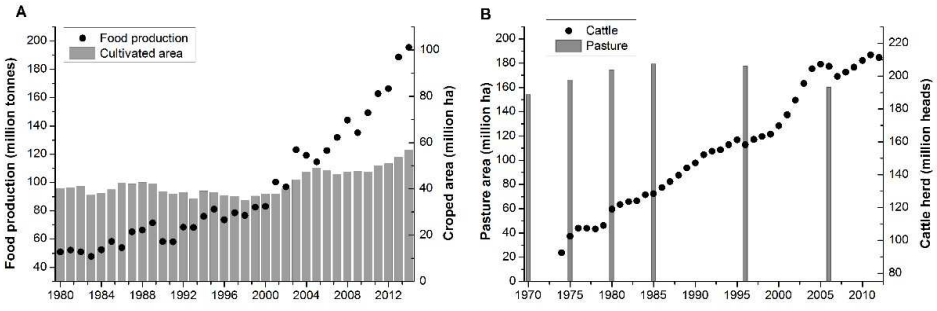

Figure 2. Food production (cereals, oil crops and coarse grains) and cultivated area (A), pasture area and cattle herd (B) in Brazil. Source: Conab (2014) and IBGE (2006; 2012; 2014).

production systems into more intensive ones through the adoption of technical knowledge (e.g. soil conservation, fertilizer, crop management) and innovation (e.g. improved crop genotypes, mechanization, double cropping). More recently, livestock production systems have also steered towards intensification as pasture area shrinks while the cattle herd size continues to increase (Figure 2B). Yet, the growth of agricultural production in Brazil was accompanied by the expansion of biofuel production, largely sugarcane ethanol (>90%; Figure 3A), as Brazil became the 2nd largest ethanol producer in the world. At the same time, there was a consistent fall in deforestation from 2003 onwards (Figure 2B).

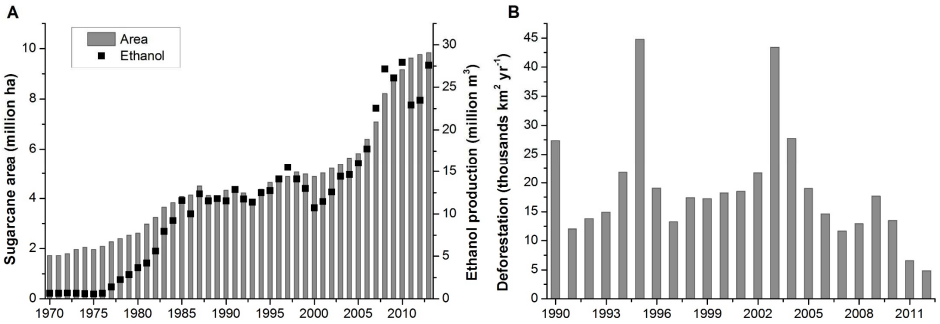

Figure 3. Sugarcane and ethanol production (A) and deforested area (B) in Brazil. Sources: Unicadata (2013), FAOSTAT (2014), Lapola et al (2014).

Discussion

The Brazilian development over the last three decades as to food security and biofuel production have been remarkable. In this process, agricultural intensification (improved technologies and crop management) played a key role in creating an enabling environment for the increase of crop and livestock output while, restraining undesirable land use change (i.e. deforestation). Although crop yields have steadily increased over the last 30 years, more recently, significant advances were achieved on livestock production. The reduction of pasture area against the continuous increase of the cattle herd are indications of more intensive production systems, which over the last decade may had limited deforestation. Sparing arable land means less environmental pressure from the expansion of cropping systems, which Brazil has been experimenting in recent years. Large potential exists because of the significant amount of area under pasture (≈2.5 times larger than the cropping area), from which relatively small efficiency gains may yield large savings of land for other uses, including biofuel feedstock production. This offers an alternative view to the common *ceteris paribus* approach that considers biofuel expansion while everything else remains the same, thus inevitably leading to food scarcity and/or deforestation. Finally, Brazil seems to offer an opportunity to rethink the interplay between food security and biofuel production in a more holistic manner, which is aware of the impacts (i.e. deforestation, high GHG emissions and poor net energy production) caused by mislead management and inappropriate biofuels - 'bad biofuels'. Yet not blind to development opportunities that may emerge from improved resource management (agricultural intensification), coupled with 'good biofuels' such as sugarcane ethanol.

Acknowledgements

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