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The political economy of sugarcane flexing: Initial insights from Brazil, Southern Africa and Cambodia¹

Ben McKay

International Institute of Social Studies (ISS), The Hague, the Netherlands

Sérgio Sauer

University of Brasília (UnB), Brasília, Brazil

Ben Richardson

University of Warwick, Coventry, UK

Roman Herre

FIAN Cologne, Germany

Abstract

In the context of rising resource demand, agricultural crops such as sugarcane are being promoted for their multiple uses in different commodity markets and as alternatives to fossil fuel equivalents (i.e. as a source of biofuel, bioelectricity and bioplastic). These commodities are also produced on an increasingly flexible basis, as sugarcane mills respond to price signals and switch between different crop uses. This paper offers a preliminary exploration into the politics of this latest development in the capitalist industrialization of agriculture. It does so by focusing primarily on flexing in Brazil and highlighting the role of the state both in creating markets for non-food products that sugarcane mills can now switch between and managing the tensions that arise from this. These tensions have concerned consumer prices for fuel, control of distribution infrastructure and conditions of land conversion, each prompting political interventions by the state. The paper then suggests how this same process is taking place, albeit shaped by different contexts, in Southern Africa and Cambodia. It concludes with some key questions for further research: is flexing eroding the distinction between crop regimes? How do primary processors decide what their product mix will be? And on what basis do state actors support flexing between agricultural products and investments in so-called bio-refineries?

Introduction

The global production of sugarcane literally outweighs that of any other crop. In 2013 it reached 2.16 billion tonnes, more than double that of maize which was the next largest crop by weight (FAO, 2014). While not necessarily an indication of the crop's exchange-value, this measurement does reveal the sheer amount of biomass produced via sugarcane agriculture and hint at the potential gains that might be had from making and monetizing other use-values from the plant. This production, associated with its expansion, also makes sugarcane an important

¹ We thank the Transnational Institute (TNI) for organizing an international workshop on 'flex crops and commodities' in January 2014 at the International Institute of Social Studies (ISS) in which an initial sketch of the main ideas for this paper was presented. We thank the participants in that workshop for their useful comments, as well as Jun Borrás and two anonymous reviewers for their comments and constructive criticisms. An earlier version of this paper has appeared in the TNI Working Paper Series on Flex Crops and Commodities (McKay et al., 2014).

case to discuss in relation to the political economy of multiple-ness and flexing, our aim in this paper.

Sugarcane has long been used in multiple ways. As Sidney Mintz charted in his book *Sweetness and Power* (1986) sugar was variously seen as a medicine, condiment, decoration and preservative before finally taking hold as a bulk sweetener during the British Industrial Revolution. Beyond its transformation into sugar, the sugarcane plant has also provided the basis for molasses and rum produced from liquid sucrose, as well as a source of steam energy by burning the cane stalks (bagasse) leftover after crushing. But recently, attempts to realize this exchange value appear to have entered a new phase as both the variety and volume of raw material produced by the sugarcane industry have increased markedly. These include more complex sucrose derivatives such as ethanol and other chemicals used for liquid fuel and plastics, more intensive use of bagasse as a solid fuel for electricity and gas generation, and the capture of 'waste' from the milling process that is turned into fertilizer and animal feed. Even the cane straw – the tops and leaves that were previously burned away from the cane stalk before harvesting – are being targeted for use with the bagasse in electricity production or for transformation into so-called 'second generation' cellulosic ethanol. In short, and in the context of a rising demand for all forms of natural resources (food, fuel, feed, fertilizer, etc.), there has been a renewed effort to create and commercialize ever-more revenue streams, or to "optimise the return on every stick of cane" as the milling group Illovo puts it (Illovo 2014b), pointing out the deepening multiple-ness of sugar sector.

We are also witnessing a greater degree of flexibility over which of these revenue streams takes precedence in the production process. It is no longer the case that all other raw materials are mere by-products of sugar. Depending on anticipated returns, many sugarcane mills in Brazil engage in arbitrage and 'flex' from one harvest to another, moving between a product mix based on 60 per cent sugar and 40 per cent ethanol, to a 40-60 split. For 2013/14, for example, the flex ratio was 48:52. In the production process, sugarcane is first crushed into a sugar-rich juice – this is the most expensive part of the operation. Next, sugar is produced first through crystallizing and centrifuging the juice, with the leftover molasses then fermented and distilled to produce ethanol. Flexing is made possible by extracting less sucrose from the juice and thereby leaving more available in the molasses. One important consequence from co-producing sugar and ethanol is that it extends the milling season and thereby allows greater use of fixed capital. This is because the total sugars content of cane remains relatively high at the beginning and end of the season, despite a decline in sucrose content. Such are the opportunities for capital accumulation in non-food markets that the owners of the biggest sugarcane milling groups now openly declare their intent to "generate value through the vertical integration of the sugar and ethanol business chain" and build whole companies "focused on the infrastructure and energy sectors" (Copersucar 2014; Cosan 2012), pointing out possible combinations of the multiple with flexible uses phenomenon.

The interest in fractioning agricultural crops into multiple industrial inputs is not unique to sugarcane. As highlighted in a recent paper by Borrás *et al.* (2015), the development of technologies to turn plants into standardised food, feed, fuel and materials that can be, or are thought to be, flexibly inter-changed, has been evident in the soybean, oil palm and maize industries, among others. Neither have trees escaped, being chemically-transformed into biofuel and bioplastic, which sit alongside other types of wood energy and construction material like pellets and timber (Kröger 2014).

At the centre of these various diversifications sit a flex narrative (Borrás *et al.* 2015) having 'bio-refineries' as the main node for flexing. According to Campanhola & Araújo (2012), these

‘bio-refineries’ are intended to transform biomass into a wide range of bio-products, deepening the participation of the chemistry and biotechnology sectors. It is widely used nowadays with different meanings, but ‘the core concept embedded in all definitions is the conversion of biomass into several product streams (materials, chemicals, energy, food and feed) and the integration of various technologies and processes the most sustainable way’ (Star-Colibri 2011, 9). However, the strategy is to develop the same approach used ‘in oil refineries to biomass (raw material fractionation, integration of mass and energy flows and integration of processes) to produce a spectrum of products and *maximise the overall added value*’ (Star-Colibri 2011, 10 – emphasis added).² One important claim made for these processing/refining operations is that they can make more by wasting less; suggesting that allocative trade-offs like ‘food versus fuel’ can be mitigated and that flexing offers an important way to meet economic demand without necessarily privileging one group over another (e.g. car drivers over food consumers).

The possible growing flexibility of sugarcane and other fungible crops has been positioned as part of the ongoing re-organization of agriculture and forestry on a global scale (Borras *et al.* 2015). Not only are these ‘flex crops’ spread over greater expanses of land – displacing other rural activities and the people that rely on them – they are also interlinked through international exchange in food, feed, fuel and other markets. For example, Brazilian exports of sugarcane ethanol to the US are in part influenced by the domestic US production of maize ethanol, which in turn is shaped by the price of feed and the supply of soybean. In addition, there are also important interlinkages being forged through ownership. The cross-commodity investments made by major traders like Bunge, Cargill and Wilmar, along with the entry into primary processing and land development by finance capital, has contributed to the horizontal integration of formerly discreet industries and created opportunities to take advantage of price and stock volatility.

The emergence of this dynamic has been linked to the cycle of global capitalism and its crises and (putative) fixes. On the one hand, flexing seemingly offers a way for agro-industrial capital to better manage the price volatility characteristic of export markets since the food crisis of the mid-2000s and for finance capital to find relatively low risk portfolio investments in the context of financial crisis and uncertain yields on loans. On the other hand, flexing also appears to respond to expectations of future profits in biomass refining and the conversion of renewable feedstocks into various raw materials. It does this by tapping into persuasive business discourses about the need for a ‘green economy’ to provide climate stability and energy and food security, especially given growing resource demands from the so-called rising powers and emerging economies in the context of peak oil (see Franco *et al.* 2010). Indeed, “*flex narratives*” themselves have emerged among state and corporate actors, used to justify investment and expansion in the boom crop sectors by highlighting the different potential uses of the land when and where convenient so as to duck criticism (see Borras *et al.* 2015).

For some scholars, then, the politics of flexing can partly be found in the way that certain flex-crop production complexes are cast as ‘win-win’ solutions to the problems of ongoing capital accumulation – including even planetary limits on continual access to cheap natural resources. In this paper we intend to add to this political economy analysis by examining in closer detail the state management of the accumulation process. Our central argument is that to reach a stage where bio-refinery flexing is possible, multiple products and the markets into which they will

² Biorefineries should be classified as part of what Fairhead, Leach and Scoones (2012, 246) described as ‘discursive commodity’ and a good example of – or a step forward on – ‘the science-policy discourse producing markets and value’, since the vision for biorefineries is meant to ‘maximise the overall added value’ (Star-Colibri 2011, 10).

be sold first have to be created and that the state is integral to this. Moreover, as the state is also called upon to manage the economy and particularly the provisioning of basic goods like food and fuel, it ends up intervening in the flexing process it has helped create. In other words, flexing is not a forgone conclusion and the political economy of this process can be found in the conflicted role of the state.

For us then, flexing goes well beyond just the proliferation and interchangeability of agricultural products. Rather, what we put forward here is a concept of flexing which involves broader linkages between sectors, actors, value chains, technological innovation, and discourses which have come to encompass the political economy of flexing in the context of a convergence of crises and the new opportunities they are creating. The emergence of new actors horizontally integrating companies from different sectors, combined with increasing vertical integration and merging has led to increased monopolization and concentration of capital. Public investment in research and development technology and subsidies favouring the production of ‘flex crops’ have all combined to render investing in certain technologies, land and transport/logistical infrastructure much more attractive to investors. While ‘flex crops’ refer to those “crops and commodities that have multiple uses (food, feed, fuel, industrial material) that can be, or are thought to be, flexibly inter-changed” (Borras *et al.* 2015, 2), we suggest it is also important to push the analysis further to consider the broader interests, relations, and actors involved in making the ‘flexing’ process possible.

To explore these issues we look primarily at the sugarcane industry in Brazil, before then asking how these dynamics differ in other, emerging centres of sugarcane flexing, especially Southern Africa and Cambodia.

Despite not being global leaders in sugarcane production, these sites also exemplify the extent to which the political economy of ‘flexing’ is reaching even the much smaller producing countries. While they may seem less significant, the increased monopolization and concentration of capital related to the political economy of flex crops is leading to very significant changes at the national and regional level, which is increasingly connected to the development of new technologies, research, and vertical/horizontal value chain integration usually advanced elsewhere. From 2005-2013 for example, Cambodia experienced the largest expansion in sugarcane area harvested worldwide with a 376% increase. Countries in Southern Africa have also experienced rapid expansion rates with Tanzania increasing its area by 50% and Zambia by 77% (FAO 2014). Further, South Africa has the largest harvested area on the continent and its companies are heavily investing in the region expanding sugarcane production and flexing. Such expansion and capital concentration associated with ‘flexing’ is having much broader and deeper effects which can and should be further analyzed with empirical-based case study research. We hope this preliminary analysis will contribute and spark new interest in research dedicated to analyzing the political economy of flex crops and commodities.

Flexing and the New Geographies of Sugarcane

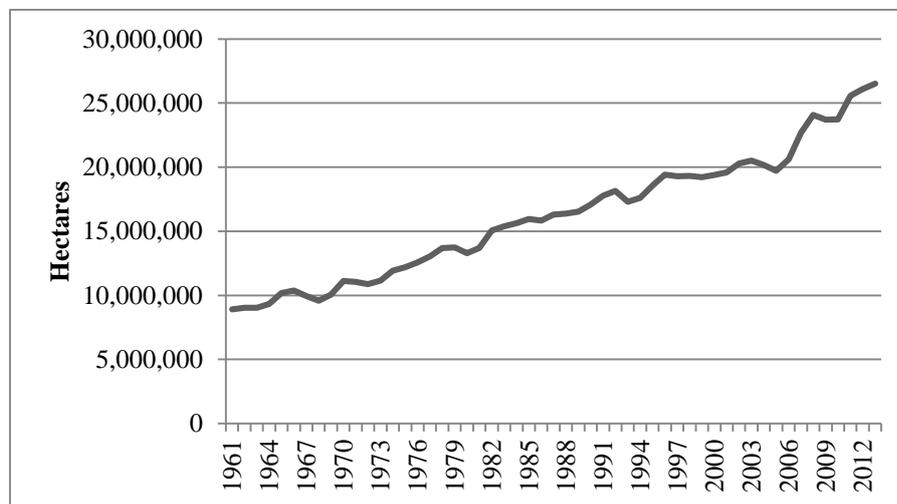
“Agro-energy is a new civilisation, a new geography for the agriculture of the world”
– former Brazilian Agriculture Minister, Roberto Rodrigues (Smith and Caminada 2007).

From 2005 to 2013, the total area of sugarcane harvested worldwide increased 26 per cent, surging from 19.7 million hectares to 26.5 million hectares (FAOSTAT 2014). During this period, then, the land mass dedicated to sugarcane was increasing at almost one million hectares per year. This rate was unprecedented since FAO records began and prompts us to ask: Was

such expansion simply a result of the growing demand for bioenergy? Or is it evidence of a new phenomenon of multiple-ness and flexing in the global sugarcane industry?

As shown in the table below, an additional 3.9 million hectares was harvested in Brazil during this time period; *more than all the other countries of the world put together*. However, some countries experienced bigger expansions in relative terms – one of our case countries, Cambodia, actually being the largest in this respect – and India, China and Thailand experienced an average growth near or above 30 per cent of their cultivated area, showing that the demand and responses for this commodity are becoming more diffuse and global, even though still dominated by Brazilian production. Of course, the sheer scale of expansion does not necessarily tell us anything about the nature of social displacement, environmental degradation or economic dislocation involved. But the changing Brazilian landscape is clearly an important place to look because it shows dimensions and important aspects of the phenomenon of flexing.

Figure 1: Worldwide sugarcane area harvested, 1961-2013



Source: Authors' own calculated from FAOSTAT database

Table 1: Countries with biggest expansion in sugarcane area harvested, 2005-2013

Rank by absolute increase	Countries	Area in 2005 (hectares)	Area in 2013 (hectares)	Absolute increase (hectares)	Percentage increase (%)
1	Brazil	5,805,518	9,835,169	4,029,651	69
2	India	3,661,500	5,060,000	1,398,500	38
3	China	1,365,777	1,827,300	461,523	34
4	Thailand	1,035,227	1,321,600	286,373	28
5	Pakistan	966,400	1,128,800	162,400	17
20	Cambodia	5,992	28,500	22,508	376
23	Zambia	22,000	39,000	17,000	77
28	Tanzania	20,000	30,000	10,000	50
34	Swaziland	50,932	56,000	5,068	10
99	South Africa	328,000	325,000	-3,000	-1

Source: Authors' own calculation from FAOSTAT database.

Brazil has truly become the world's 'sugar bowl'. In 2012 the country was the leader in world sugar production (22 per cent) and sugar exports (46 per cent) (FAO 2014; USDA 2013a). But as we stressed in the introduction, sugarcane production is about much more than just sugar. Brazil is the second biggest producer of ethanol in the world (27 per cent of world total, almost all of which is distilled from sugarcane) behind the US (57 per cent, mostly from corn), and between them these two countries dominate the renewable fuel markets (RFA 2014). Although there is some trade and investment between them – prompting some scholars to articulate a potential 'ethanol assemblage of the Americas' (Hollander 2010) – it remains the case that most ethanol intended for transport fuel is sold domestically. Brazil has consumed, on average, 86 per cent of its ethanol production since 2006 (Wilkinson and Herrera 2010).

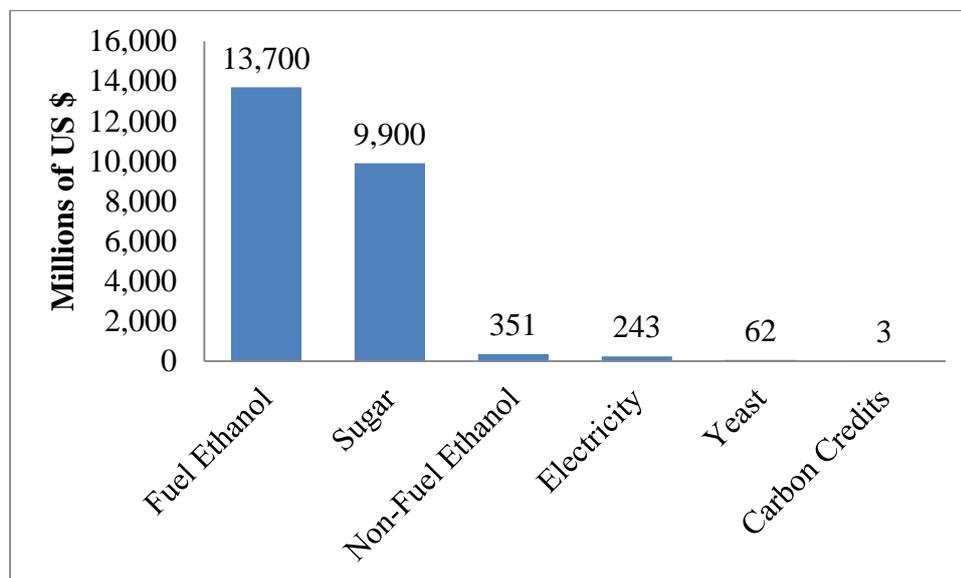
Moreover, other uses for ethanol are being found. In 2012 about 12.5 per cent of the country's ethanol was used for non-fuel products – including everything from cleaning products to perfumes – up from 6 per cent a decade previously (*Financial Times* 2012). That same year, around 3 per cent of Brazil's electricity requirements were met by sugar mills selling bagasse-generated energy, a ten-fold increase since 2005 (Souza 2014). Through the generation of bio-electricity, Brazilian mills have also been able to acquire carbon credits under the UN's Clean Development Mechanism and thereby monetise another aspect of the production process. The argument goes that by investing in new boilers and turbines to generate electricity – both for their own production sites and through export to the grid – mills can claim that they are displacing 'dirtier' electricity that would otherwise be made by burning fossil fuels. However, the use of the Clean Development Mechanism to exploit the multiple-ness of sugarcane use has been controversial. Some critics question whether the bio-electricity projects deserve additional carbon market finance since they would likely have been built anyway, while others point to the non-carbon costs (e.g. loss of biodiversity, exclusion of other land-users) on which these projects are predicated (see Wittman 2012).

Calculations on the relative value of these multiple sugarcane revenue streams are detailed in the graph below. Based on their sales price in consumer markets, and after deducting the amount paid in tax to the state, it shows that in 2008, at the peak of the sugarcane boom in Brazil, US\$13.7 billion was made through fuel ethanol, US\$9.9 billion through sugar and just under US\$0.7 billion through other products. These figures show that, despite its multiple uses, the sugarcane portfolio is still dominated by food and fuel outputs. What will be interesting to explore further is the potential evolution in this portfolio, especially if cellulosic biofuels come on-stream. Will this mean demand for ethanol can be satisfied by processing bagasse, leaving more sucrose for sugar and export to the world market? If this does happen, will more plant material be taken from the field to provide the necessary feedstock, meaning greater reliance on chemical fertilisers and pesticides to maintain soil fertility and cane yields? Or will less bagasse be burned in the mill reducing the amount of electricity sent to the grid? Contrary to the idea that bio-refining avoids the need for trade-offs, we would suggest that they are probably just a little harder to see as the market effects of changes in relative prices have become more dispersed.

As pointed out by Franco *et al.* (2010) for example, dominant narratives regarding the European Union's biofuels policy are often promoted by the three main claims: environmental protection (to combat climate change); energy security (as a response peak oil and foreign energy dependence); and rural development (to combat rural poverty and hunger). However, such assumptions fail to consider that crop use change often leads to land use change, as crops are diverted from one market (i.e. food) to another (i.e. fuel) and higher food prices induced pasture- and forest-land to be converted into arable-land. This process undermined the EU's

‘triple win’ claim, and, as we show below, it has also been experienced in Brazil. Examining the effects on commodity buyers, Joseph Baines (2015) has shown how corn-based biofuel production in the US had the effect of pushing up feed prices and hurting the domestic animal processing industry and livestock farmers based outside the Corn Belt. As Baines put it, rather than avoiding inter-capitalist trade-offs, the ethanol boom has been a “vector of redistribution” (p. 1). In the case of Brazilian sugarcane, to the extent flexing toward ethanol puts an inflationary pressure on world sugar prices it will increase input costs for food manufacturers in Brazil’s major export destinations in China, Southeast Asia and North Africa – an issue we return to in the conclusion. However, the focus of our paper in the first instance is to show how the shift to fuel production by sugarcane millers in Brazil has exposed them to the vagaries of domestic energy politics.

Figure 2: Market value of Brazilian sugarcane revenue streams, 2008



Source: Authors’ presentation of data in Neves *et al.* 2010.

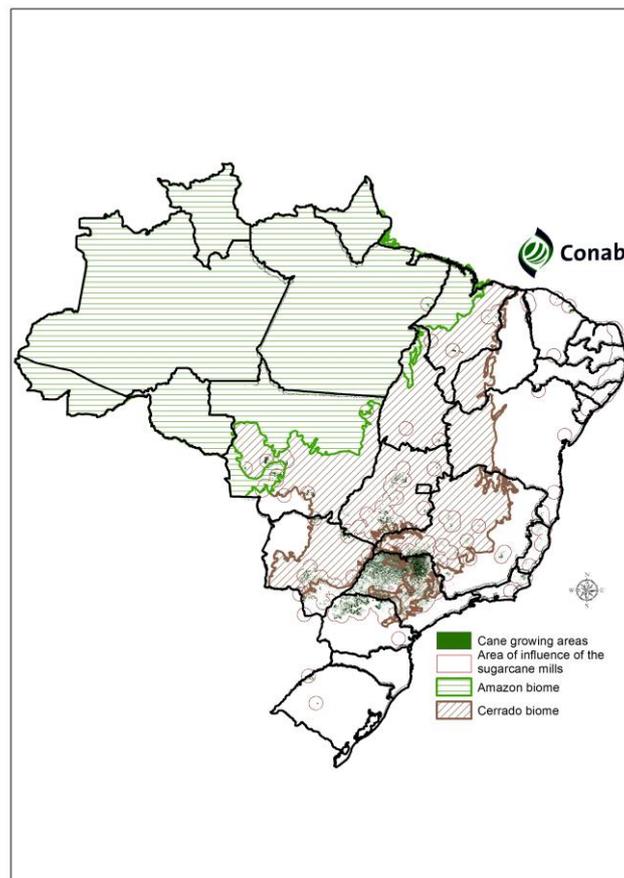
Keeping with Baines’ notion of biofuel as a vector of redistribution, we can also identify unequal changes to income and livelihoods in the sugarcane sector. Geographically, planting and processing is largely located in the South-Central region of Brazil. According to data from the Brazilian Sugarcane Industry Association (UNICA in its Brazilian acronym), the state of São Paulo (SP) accounted for 53 per cent of the total area cultivated in Brazil, with Minas Gerais (MG), Goiás (GO), Parana (PR) and Mato Grosso do Sul (MS) adding another 30 per cent between them (UNICA 2013a). One consequence of this has been an uneven experience of rural land price inflation, which rose fastest of all in São Paulo state, increasing 57 per cent between 2005 and 2011 and leading to new dynamics of agrarian change (SugarOnline 2011).

Whilst serving as a boon to rural landowners selling or renting out land for sugarcane cultivation, such inflationary pressure has made it more expensive for the government to acquire land for the restoration of indigenous land or settlements of landless peasants. It has also displaced existing livestock and agricultural production, thereby leading to the conversion of pasture land to arable land and creating incentives for expansion or intensification of beef and dairy production as farmers and ranchers are squeezed out of their existing sites (see Sauer and Leite 2012; Wilkinson and Herrera 2010; Novo *et al.* 2010; Hermele 2012). Moreover, to

the extent that a switch to ethanol production has reduced sugar exports – as happened in 2007-2008 – the upward pressure on the world sugar price has created incentives for producers in other countries to also convert land to sugarcane (HLPE 2013).

According to the map below – different from the argument used by the sugarcane industry to distance itself from allegations that it is contributing to deforestation – the expansion of sugar cultivation is basically within the Cerrado biome, the second largest biome after the Amazon, with extensive environmental impacts (Sauer and Pietrafesa 2012). The decisions to plant new fields to sugarcane (‘land-use change’) or even to change the markets that sugarcane is sold into (‘crop-use change’) have complex knock-on effects far beyond the borders of current cane growing areas, and indeed, Brazil itself (see Borrás *et al.* 2015).

Figure 3: Cane growing areas in Brazil



Source: CONAB – 2014

The ownership of the sugarcane industry also has a changing geography. In 2006, just 3 per cent of sugar mills were funded with foreign capital; in 2012 this had increased to 33 per cent – a virtual foreign takeover of the milling industry (Novacana 2013). The milling sector itself is also becoming increasingly concentrated. Seven milling groups control 55 per cent of Brazil’s sugarcane production with smaller, often family or cooperative-owned mills, disappearing due to indebtedness and takeovers (see Table 2 below). This process has enabled tighter policy coordination and greater class consciousness on the part of capital, evident in UNICA’s transnational lobbying efforts via its offices in Brussels and Washington D.C. and the ‘More Ethanol’ Movement that brought together corporate elites, politicians and civil servants in Brasilia to boost industry expansion.

The changing dynamics of ownership are in part a result of the economics of flexing. Firstly, investing in the factory technology to manufacture multiple products is an expensive business. To build a new mill that crushes 3-4 million tonnes of cane per year has been estimated at around US\$500 million, excluding the cost of bringing extra land under cane production (Reuters 2011a). Secondly, to ensure that markets can be found for non-food products, many milling companies have sought to extend their vertical integration downstream and guarantee access to fuel distribution infrastructure. For these two reasons, milling groups have needed additional finance and expertise, and in order to acquire it turned to mergers and acquisitions.

For example, in 2011 and following its recent stock market floatation, the sugarcane conglomerate Cosan launched a joint venture with Royal Dutch Shell to produce Brazil's second largest sugar-ethanol corporation Raízen (Shell 2011). Also in 2011, British Petroleum bought out the mills Tropical BioEnergia and Companhia Nacional de Açúcar e Álcool, while the next year, the recently corporatized Copersucar acquired a controlling stake in Eco-Energy in order to access major fuel distributors in the US (Fick and Flynn 2011).³ Neither has it just been Brazilian millers partnering with European/American traders and oil companies. In 2010, and following its own partial stock market floatation, the Brazilian energy company Petrobrás spun out an ethanol-arm and went into business with French sugar producer Tereos to form Guarani, whilst also agreeing with the São Martinho group to take a stake in what will become Brazil's biggest single biomass refinery, the Boa Vista mill in Goiás (Reuters 2010). Meanwhile, in order to develop second-generation biofuels from sugarcane cellulose rather than sucrose, Petrobrás formed a partnership with US-based KL Energy Company, and plans to open a bagasse-processing ethanol plant in Brazil in 2015 (Petrobras 2014).

However, after this boom period there came a bust, which brought its own mechanisms of restructuring. Tight margins on sugar/ethanol prices, bad weather and limited credit in the wake of the global financial crisis all played their role in the sudden inability of many mills to pay down their debts as quickly as expected or roll them over by borrowing more. The collective debt of the industry thus ballooned, and was expected to reach R\$63 billion by the end of the 2013-2014 crushing season (Almeida and Kassai 2013). This led to dozens of mills being mothballed, which have in turn laid off thousands of workers, some still owed wages. The most insolvent mills have even faced the threat of bankruptcy proceedings, allowing their competitors to buy them up on the cheap, concentrating the industry even further. According to Dario Costa Gaeta, chief executive of the Paraiso Bioenergia mill which itself narrowly avoided bankruptcy, this dynamic is likely to wipe out the vast majority of the remaining 250 family-owned mills over the next decade or so, leaving the sugarcane sector – and flexing decisions – in the hands of the milling oligopoly (Ewing 2013).

Table 2: The corporate control of Brazilian sugarcane

Company	Mills / Related Assets in Brazil	Production/year	Share of Brazilian market
Copersucar S.A (2014 – merger with Cargill, 50 per cent owned by each company)	Controls exclusive sale of sugar and ethanol volumes produced by 47 member mills and 50 non-member units	Sugar: 6.9 million tons Ethanol: 3.7 billion liters	Sugar-Ethanol complex (inc. transportation, storage, processing commercialization): 22 per cent Sugar sales: 19 per cent

³ In 2014, Copersucar also launched a joint venture with Cargill to strengthen its sugar marketing. This venture is the biggest sugar trading operation in the world.

			Ethanol sales: 16.3 per cent
Raizen (2011 merger - Royal Dutch Shell and Brazilian conglomerate Cosan)	24 mills 4,700 Shell service stations 54 airports 60 terminals	Sugar: 4 million tons Ethanol: 2 billion liters	Sugar-ethanol complex: 9.5 per cent Sugar: 11 per cent Ethanol: 8.8 per cent
Biosev (2009 merger – Louis Dreyfus Commodities sister company after merging with Brazilian sugarcane producer and processor Santelisa Vale)	12 mills	Sugar: 2.8 million tons Ethanol: 1.8 billion liters	Sugar-Ethanol complex: 7 per cent
Odebrecht Agroindustrial (Brazilian-based engineering, construction, and chemical conglomerate)	9 mills	Sugarcane: 40 million tons Ethanol: 3 billion liters	Sugarcane: 6.8 per cent Ethanol: 13.2 per cent
Guarani (Acquired by French sugar conglomerate Tereos in 2002; Petrobrás buys 46 per cent stake in 2011)	7 mills	Sugarcane: 20 million tons Sugar: 1.9 million tons Ethanol: 860,000 m ³	Sugarcane: 3.4 per cent Sugar: 5.2 per cent Ethanol: 3.8 per cent
Bunge (US-based food processing corporation)	8 mills	Sugarcane: 21 million tons	Sugarcane: 3.6 per cent
Adecoagro (Argentina-based company heavily backed by US billionaire George Soros)	3 mills	Sugarcane: 17 million tons	Sugarcane: 2.9 per cent

Source: Authors' own from various data sources.

Regarding the Brazilian sugarcane crop, sugar and ethanol are still the main drivers for investments and the national expansion of planting, with sugar basically going to the international market and ethanol being consumed domestically. As far as it is possible to understand, these destinations are usually based on prices of the commodities and market opportunities. Beyond sugar and ethanol production, there are other destinations which point to multiple uses, justifying the sugarcane crop as part of a clean development strategy. The most important aspect of sugarcane production in Brazil, however, is the strong process of concentration and horizontal integration through purchases, joint ventures, and mergers of sugar mills. Such process brings about different actors and interests – from biotech industries to oil companies, including international agribusiness traders and food chain groups – materializing an important aspect of the phenomenon of flexing crops and commodities.

The Role of the State in *Making Flex Crop Markets*

We are and will continue to be world champions in clean energy, a country that will always know how to pursue healthy, balanced growth. Ethanol and hydro energy source will be greatly encouraged, as well as alternative sources: biomass, wind and solar energy
– Brazilian President Dilma Roussef in her inaugural speech to Congress (Huffington Post 2011).

The story presented so far, and one frequently repeated by the sugarcane industry itself, has been one of industrial innovation and private sector growth. However, as the quote from Dilma

shows, the Brazilian state has explicitly championed bioenergy and, as we shall see, sugarcane biofuel in particular. Again this raises important scholarly questions for how we understand the political economy of flexing. Are only agribusiness traders (national and international), oil companies, banks/trust funds, biotech and construction companies responsible for the multiple and flexible use of crops? What is the role of the State/government in flexing sugar crops? And on what basis are these often controversial decisions publicly justified?

It is important to acknowledge the role of the state in making the non-food markets into which (certain) industrial capitals have been able to circulate and expand – a feature which can be traced from the 2010s in the quote above, right back to the 1930s. We focus here on industrial policy targeted at non-sugar markets specifically, though others have identified ‘subsidies’ that support the sugarcane industry as a whole.⁴ The role of the Brazilian state in the politics of sugarcane ‘flexing’ is usually dated to the 1975 Pró-Álcool programme, but in fact the first ethanol blend mandate of five per cent was put in place in 1931 (Costa *et al.* 2011). That said, it was not until the 1973-74 oil price crisis that Brazil’s ethanol industry really started to develop. In 1975 Brazil’s military government initiated the Pró-Álcool programme to support and promote ethanol production from sugarcane and cassava, although it was only the former that had the capacity to respond to state incentives. As an alternative transport fuel, ethanol production was intended to increase Brazil’s energy independence and reduce oil imports. With Pró-Álcool, the state provided subsidies and credit guarantees for the expansion of sugarcane distilleries and processing plants, continued and slowly increased the ethanol-blend mandate for gas-powered vehicles, and applied import tariffs and export taxes on sugar in order to stimulate domestic sugarcane-ethanol production (Schmitz *et al.* 2003).

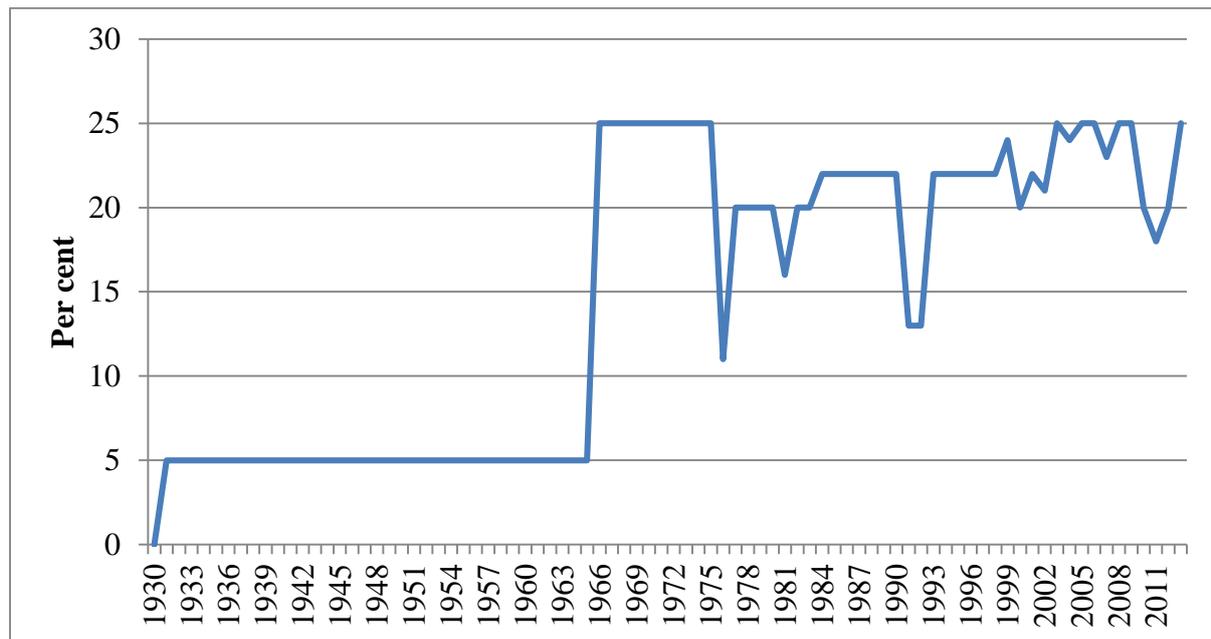
In the late-1970s, Brazilian subsidiaries of automobile corporations began to produce ethanol-fuelled cars. The state continued to intervene by providing subsidies and favorable credit terms for sugarcane producers, while applying an extra tax on gasoline, bans on diesel-powered cars and public procurement mandates for the new ethanol-powered cars (Pelkmans *et al.* 2008). By 1986, almost all new automobile purchases were of ethanol-fuelled cars and a distribution infrastructure that allowed ethanol to be sold in almost all the country’s 30,000 filling stations had been put in place (HLPE 2013). Incentives for research were given to institutes and universities, however, the steep drop in oil prices in 1985-86 which remained below US\$30/barrel until 2000 slowly crippled Brazil’s Pró-Álcool programme, which was made worse from the point of view of drivers by the fact that high sugar prices meant mills diverted sugarcane away from the fuel market. Under the neo-liberal policy leanings of the Cardoso government (1994-2002), state powers to set prices and production quotas for sugarcane were renounced and by 1998 gasoline and ethanol prices fluctuated more freely with the market (Pelkmans *et al.* 2008).

The surge in oil prices in 2004-05 coupled with popular discourses of climate change, energy security, and rural development reignited world ethanol production and Brazil’s ethanol-based fuel economy was revived (see Franco *et al.* 2010). The ethanol industry further benefitted from the launch of flex-fuel vehicles in Brazil in 2003 – capable of running on gasoline, ethanol, or any combination of the two – which have taken over Brazil’s automobile industry, representing 95 per cent of current monthly sales and 62 per cent of the country’s total fleet

⁴ For example, Patrick Chatenay has argued that Brazilian agriculture, including sugarcane, benefits from a reduced mandatory contribution to the government pension fund scheme INSS. Farming pays a special tax, informally called ‘Funrural’, defined as 2.1-2.6 per cent of revenue instead of the standard 28.3 per cent on payroll that non-agricultural sectors contribute, with the remainder picked up by the Brazilian Treasury. Chatenay puts the benefit of this for sugarcane farming at US\$800 million for the 2012/2013 crop year alone (Chatenay 2013).

(UNICA 2014a). Despite partial deregulation of fuel pricing, the Brazilian government has retained its use of ethanol mandates, using it as a means of supply-management to stabilize sugarcane prices rather than to reduce oil consumption or offset high world oil prices (Schmitz *et al.* 2004). This much is corroborated by the USDA, which put the decision by the Brazilian government in February 2013 to increase the blend ratio from 20 per cent to 25 per cent down to an “expected higher sugarcane crop and higher availability of the product” (USDA 2013b). The graph below shows the ethanol-use mandate since its inception in 1931 and illustrates its underpinning of market demand.

Figure 4: Brazilian ethanol blend mandate, 1930-2013



Source: Authors' adaptation from Puerto Rico 2007; USDA 2013a.

Note: between 1966 and 1977 blending was mandatory up to the ranges shown.

Another important political tool has been taxation policy. In 2002, just before the launch of the first flex-fuel car in Brazil by Volkswagen, the Brazilian government extended to flex-fuel vehicles the same tax exemption that ethanol-fuelled vehicles had traditionally received over gasoline-powered cars (USDA 2013b). Differentiated tax rates have been applied to the fuel as well as the vehicle. The Contribution to the Social Integration Program/Contribution for Financing Social Security (PIS/COFINS in its Brazilian acronym) applies an extra tax on gasoline to the equivalent of R\$0.26/litre (around US\$0.11/litre), which currently does not apply to ethanol (USDA 2013b). Further, in São Paulo, the heartland of sugarcane production, state sales taxes have been placed on gasoline and hydrous ethanol but not anhydrous ethanol (the type used in flex-fuel cars) and, further, in 2011, Governor Geraldo Alckmin eliminated a tax on equipment that produces bioelectricity from sugar cane.

But perhaps the most important discretionary mechanism by which sugarcane ethanol and 'flexing' has been promoted has been through state-credit. The Brazilian Social and Economic Development Bank (BNDES in its Brazilian acronym), a state-owned financing corporation, has historically played a major role in the development of Brazil sugar-ethanol industry. It has been claimed that during the late-1970s, during the height of the Pró-Álcool programme, the amount of cheap credit provided by another state-owned bank, the Banco do Brasil, made it

the largest agricultural lender in the capitalist world (Burbach and Flynn 1980). In the contemporary period, between 2006 and 2010 annual subsidised credit allocation by the BNDES for investment in distilling machinery and equipment jumped from US\$143 million to US\$849 million, while credit for energy cogeneration grew from US\$84 million to US\$206 million. At the same time, credit extended to mills for increased sugarcane production – either as working capital or investment capital – jumped from US\$519 million to US\$1,121 million. By 2010, the total amount of subsidised credit available for the industry had reached an all-time high of US\$3.1 billion per annum (USDA 2011; see also Sauer and Pietrafesa 2012; Wilkinson *et al.* 2012).

Since this date, various other credit lines have been created to service the growth of the sugarcane ‘bio-economy’. In 2011, BNDES and the Funding Authority for Studies and Projects Agency (FINEP in its Brazilian acronym) of the Ministry of Science and Technology announced the Joint Plan to Support Industrial Technological Innovation in Sugarcane Sectors (PAISS Agrícola in its Brazilian acronym). This supported 35 business plans with R\$2.5 billion “aimed at providing support to industrial-technological innovation in the sugar-based ethanol and chemical sectors” (UNICA 2014b). In 2014 it was renewed and R\$1.5 billion made available for what it calls ‘agricultural-technological innovation’ in the sugar-ethanol sector. These included credit lines for transgenic crops, precision harvesting (so as to collect more biomass), integrating production processes and adapting industrial systems in other sectors to enable them to use ethanol as a raw material (Sauer and Pietrafesa 2012). Moreover, it is not just through the credit system that the industry’s financial woes have been alleviated. Monies owed by mills to the state have been reduced through the Brazilian government’s tax-resettlement programme for ‘distressed companies’ (REFIS in its Brazilian acronym). Among others, this has been taken up by Guarani to renegotiate and reduce its US\$42 million tax bill (Chatenay 2013: 18).

Public resources have also been pouring in several public-private researches and technological development initiatives. In 2007, the Brazilian government created ‘EMBRAPA Bioenergy’, a branch of the Brazilian Agricultural Research Company (EMBRAPA in its Brazilian acronym). This was fully dedicated to advance research in the following areas: the development of technologies for the expansion of sugarcane cultivation in new areas; the search for alternative sources of bioenergy (including second generation of ethanol from trees and other biomass)⁵; and the development of adapted varieties and cropping systems adapted to multiple soils and climates. Furthermore, public funding from BNDES and FINEP are also funnelled to support research at the Sugarcane Technology Center (CTC). This research center, owned by corporate sugarcane giants Cosan and Copersucar, operated with R\$ 500 million in 2011, with its financial support provided by BNDES (R\$ 207 million), FINEP (R\$ 150 million), and the remaining R\$ 100 million from CTC’s members/owners.⁶

Finance has also been extended for distribution infrastructure, a key requirement of any ‘flexing’ project. In 2011 Logum Logística, a joint venture backed by Petrobrás, Copersucar, Raízen and Odebrecht among others, received a US\$924m loan from BNDES to begin building a giant ethanol pipeline, 830 miles long, connecting the states of São Paulo, Minas Gerais and Goiás to consumption sites in the country’s south-east (Nielson 2011). This pipeline is of

⁵ In 2014, Embrapa bioenergy signed a cooperation agreement with the World Agroforestry Centre (ICRAF) to undertake projects within the Program for the Development of Alternative Crops for Biofuels, receiving US\$ 3.5 million from the International Fund for Agricultural Development (IFAD) for the first phase of the project.

⁶ Such amount is a considerable sum considering that, according to CTC’s own prevision, public and private annual investments in ethanol research was around R\$ 150 million in 2010.

particular importance as these three states alone account for almost 70 per cent of sugarcane production in Brazil and will reduce dependence on costly road haulage to transport the ethanol around (UNICA 2013a). Meanwhile, to make sure that enough raw material was available to supply these intended product markets, and to provide some support to cane farmers as well as millers, BNDES also launched Prorenova in 2012. This was designed “to encourage the production of sugarcane by financing the renovation of old sugarcane farms and the expansion of the cultivated area” with a budget of R\$4 billion and to encourage uptake since its launch, has reduced its interest rates, increased available funding per hectare, and extended applicability to foreign-owned companies (BNDES 2012; SeeNews 2014).

Neither has this activity by the BNDES been restricted solely to Brazil. As compiled by John Wilkinson (private communication, on file with authors), BNDES has recently financed sugar-ethanol projects in Angola (Oderbrecht in cooperation with Damer and the state-firm Sonangol), Ghana (Northern Sugar Resources), Mozambique (Petrobrás with Companhia de Sena and the state-firm Petromoc). It also financed Brazilian engineering firm Dedini for the construction of a plant in partnership with Kenana Sugar Company in Sudan, provided an US\$80m loan to Kenya in the form of agricultural machinery including 2,000 sugarcane tractors, and signed a cooperation agreement with the public Industrial Development Corporation in South Africa to prioritize lending to flex-fuel cars, co-generated renewable energy and agro-industry. The capital-intensive model of sugarcane farming and refining favoured in Brazil has aided firms supplying machinery, equipment, infrastructure and engineering services, as well as industrial capital involved in milling.

International lending by the BNDES, then, has formed part of a concerted state project – led most enthusiastically by the Lula government of 2003-2010 – to turn sugarcane ethanol into a global commodity. Thus, alongside credit with favourable conditions (but not concessionary rates), the Brazilian state has also promoted sugarcane flexing abroad through diplomatic efforts to encourage adoption of biofuel policies in African countries and through the technical advice of the African-branch of EMBRAPA to cultivate sugarcane and construct bio-refineries (see Campanhola and Araújo 2012). Finally, the Brazilian government has been ardent supporters of agricultural trade liberalization, with the 54 cent/gallon tariff placed by the US on biofuel imports among its particular bugbears. After applying pressure on the US to promote ethanol in a more liberal fashion – teaming with Brazil to develop the fuel globally, rather than insulating itself and closing off the domestic market – the tariff was finally repealed at the end of 2011, publicly celebrated by UNICA among others.

More detailed empirical research – especially information about how the sugar-ethanol flex ratios are set by individual mills – is needed to demonstrate how state policy shapes current flexing practice. However, what we can discern in the Brazilian case is that the very possibility for sugarcane flexing has been predicated on several governmental initiatives and policies that clearly encourage private actors to invest in the processes of multiple-ness and flexing. As mentioned above, there are credit incentives, creation of institutional market – through establishing the blend ratio – tax breaks, but also the allocation of public funds for research and technological development (including support from multilateral organizations), to create the material conditions for “real flexing” (Borras *et al* 2015) of the sugar crops in Brazil and beyond.

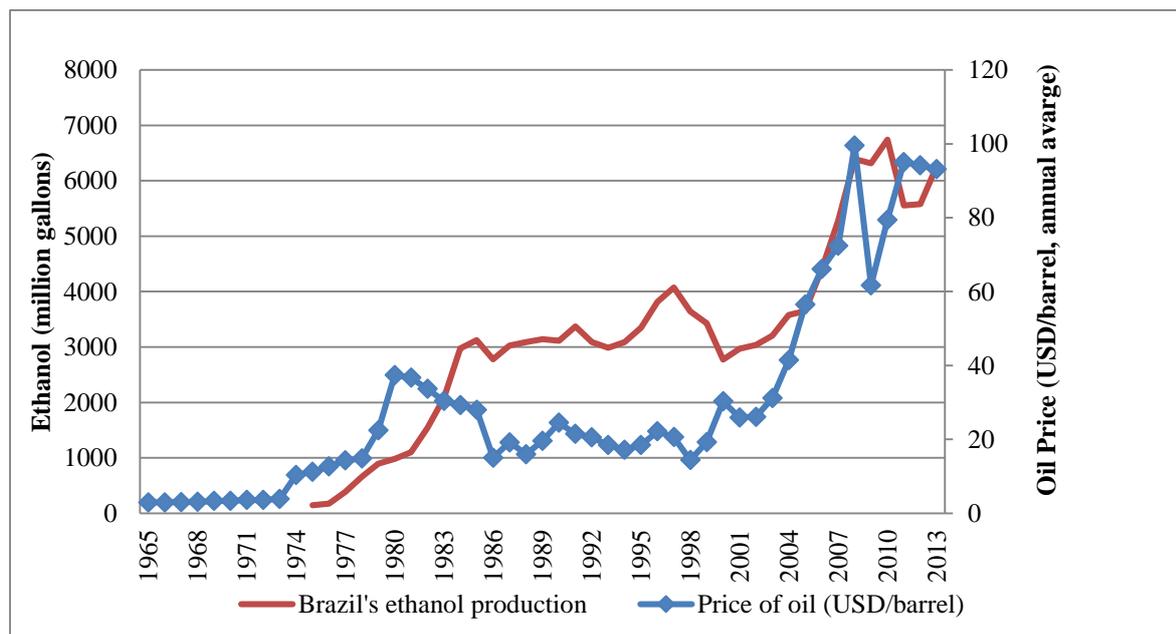
The Role of the State in *Managing Flex Crop Markets*

Questions of a regulatory nature will be an important topic at the [2013 Ethanol] Summit, because these are what will ensure the competitiveness of renewables against fossil fuels
 – Elizabeth Farina, CEO of the Brazilian Sugarcane Industry Association (UNICA 2013).

The previous section showed how the Brazilian state has been dedicated to the promotion of multiplying the uses and market value of sugarcane. Yet as the quote above from the CEO of UNICA hints at, there have in fact been many points of tension between those actors with a commercial interest in the sugarcane complex and those regulating the sector in government and other state agencies. In theoretical terms, this is an example of the dialectical relationship between accumulation and legitimacy that must be managed by the capitalist state. Perhaps nowhere is this more evident in our case than in fuel pricing and the political decisions that have been necessitated by sugarcane millers' capacity to flex. The relationships between (and within) certain state and capitalist actors (accumulation strategies), as well as with societal actors and movements (legitimation strategies) are important to understand and require much deeper empirical based research (Fox 1993). How, under what circumstances, and to what extent does the state facilitate and/or hinder flexing capabilities? Here we point to some of the more evident relationships and mergers between the Brazilian state and capitalist actors, as well as international market price signals and their relation to sugar-ethanol production and uses.

To appreciate the impact of flexing on the consumer goods market for fuel, it is important to first outline the relationship between ethanol production and the price of oil (used to make gasoline). Figure 5 shows a positive correlation between these two variables. A strong claim can be made for causality too: the oil price crisis in 1973-74, for example, was clearly connected to the government's *Pro-Álcool* programme, while the eventual decrease in oil prices led to the programme's demise as fixed ethanol prices could no longer be publicly justified. During the last decade however, oil prices increased once again, moving rapidly upward from 2003 to 2008. This coincided with the launch of Brazil's flex cars in 2003 and undoubtedly contributed to the sugarcane boom of the mid-2000s (along with the food price crisis and 'rush to farmland', in which the oil price was also a driving factor).

Figure 5: Brazil's ethanol production and real world oil prices, 1965-2013



Source: adapted by authors from FRED 2013 and RFA 2013.

Since its 2008 peak, however, the oil price has faltered, dampening further price rises for gasoline at the pump. Allied to this has been the anti-inflationary strategy of the Dilma government (first term 2011-2014). In the same inauguration speech in which she vowed to champion clean energy Dilma also outlined her determination to prevent the ‘poison’ of inflation from eroding real wages (Huffington Post 2011). Her government has sought to do this primarily by keeping gasoline prices down, applying pressure on Petrobrás to import extra oil and sell it at below cost, whilst also cutting federal gasoline taxes (Almeida and Kassai 2013).

The consequence of this has been felt acutely by ethanol producers, which have lost competitiveness against gasoline and are thus less able to convince flex-fuel drivers to switch from the gasoline-blend to 100 per cent pure ethanol. Table 3 shows the ratio of ethanol to gasoline prices in Brazil’s top three sugarcane producing states and suggests that the price incentives to switch to pure ethanol have been few and far between (because ethanol burns faster than gasoline, it is reckoned that ethanol must be below 60 per cent of the price of gasoline to encourage customers to switch). As a consequence, while 82 per cent of Brazil’s flex-fuel cars were filling up with pure ethanol in 2009, by 2013 this had dropped to roughly 24 per cent (Almeida and Kassai 2013).

Table 3: Ratio of pure ethanol to gasoline-ethanol prices in Brazil, 2010-2013

		2010	2011	2012	2013
São Paulo	January	73 per cent	70 per cent	71 per cent	69 per cent
	February	73 per cent	71 per cent	68 per cent	68 per cent
	June	53 per cent	64 per cent	68 per cent	65 per cent
	August	57 per cent	68 per cent	66 per cent	n/a
Minas Gerais	January	79 per cent	75 per cent	78 per cent	74 per cent
	February	83 per cent	76 per cent	77 per cent	73 per cent
	June	70 per cent	74 per cent	76 per cent	73 per cent
	August	65 per cent	75 per cent	75 per cent	n/a
Goais	January	69 per cent	68 per cent	69 per cent	71 per cent
	February	71 per cent	70 per cent	68 per cent	69 per cent
	June	53 per cent	63 per cent	69 per cent	66 per cent
	August	57 per cent	65 per cent	67 per cent	n/a
Area shaded in grey indicate that ethanol prices are low enough to encourage a consumer switch					

Source: Adapted from data in USDA 2013b.

What is being argued here is that the Brazilian state has balanced support for ethanol production against consumer fuel prices. Sometimes it has mediated this relationship indirectly – as in the case above, or by promoting the exploitation of offshore oil deposits – but sometimes directly. In 1999 for example, one of the Brazilian anti-trust agencies, the Secretariat of Economic Law, disbanded a collective organisation of ethanol producers called Brasil-Álcool on the basis that they formed a cartel intent on raising consumer prices in the fuel market.⁷ Meanwhile, at the

⁷ Brasil Álcool was established in 1999, ostensibly in response to deregulation, by 84 fuel ethanol producers accounting for 70 per cent of Centre-South production. Led by Copersucar, this was designed to collectively sell their output and store any excess supply (OECD no date).

beginning of the Dilma government, regulatory oversight of ethanol was moved from the Ministry of Agriculture to the Ministry of Energy, with the government immediately exploring the possibility of applying export taxes on sugar to divert Brazilian sugarcane into the domestic fuel market (Reuters 2011b).⁸

A second aspect of flexing necessitating state management relates to the control of infrastructure. As noted already, the production of energy (fuel, electricity) over a greater spatial area has required investment in distribution infrastructure. The activities of Cosan are instructive here. In 2011 it invested US\$695 million to construct the largest sugar terminal in the world as well partnering in Logum Logística, the ethanol pipeline project mentioned previously. In 2012 it also paid US\$1.8 billion for control of Brazil's largest gas distribution unit and followed this in 2014 with a US\$3 billion bid for the nation's largest railway operator, América Latina Logística (ALL) (Bloomberg 2014).

One concern for state regulators here is whether this will lead to monopoly control. In the case of the Logum Logística pipeline, another of Brazil's anti-trust agencies, the Administrative Council for Economic Defense, did eventually approve the deal – although apparently deliberated over the possibility of installing a rival pipeline to provide some competition.⁹ At present, the ALL railway network deal remains subject to approval: again, there is concern about whether Cosan will prioritize sugar freight over other commodities such as soybeans and/or charge rival sugar producers higher fees. Consequently, state regulators have deliberated whether to block the deal or require the companies to sell assets or guarantee equal pricing (Bloomberg 2014). In other words, the vertical integration into distribution infrastructure being precipitated by increasing production and industrial concentration has knock-on consequences for other commodity complexes that require mediation by the state. Like inter-capitalist conflicts that have arisen out of the biofuels boom in other parts of the world – e.g. livestock and final food producers in the US complaining about the higher prices of maize – this is likely to remain another source of potent political conflict.

A third aspect of state management relates to land. We have already noted the way that sugarcane flexing has been yoked to discourse about clean energy, sustainability and green growth. For example, Vasco Dias, Chief Executive of Raizen, has said of cellulosic ethanol that: “This is the cleanest solution possible: taking rubbish – bagasse, biomass – and transforming it into fuel” (*Financial Times* 2012). Indeed, industry representatives now even talk about the use of cane leaves and tops allowing them to ‘grow vertically’, meaning into the air and thereby reducing the pressure to expand the planted area (Jank and Perina 2011). But a *quid pro quo* of this strategy is that the sugarcane industry has had to be seen to be managing their environmental impacts. For example, Braskem, which make plastic bags from ethanol, have admitted that:

Technically speaking, it doesn't make a difference whether we use cane or corn ethanol but it's very important for marketing...Our end customers want products that don't directly compete with the food chain. (*Financial Times* 2012).

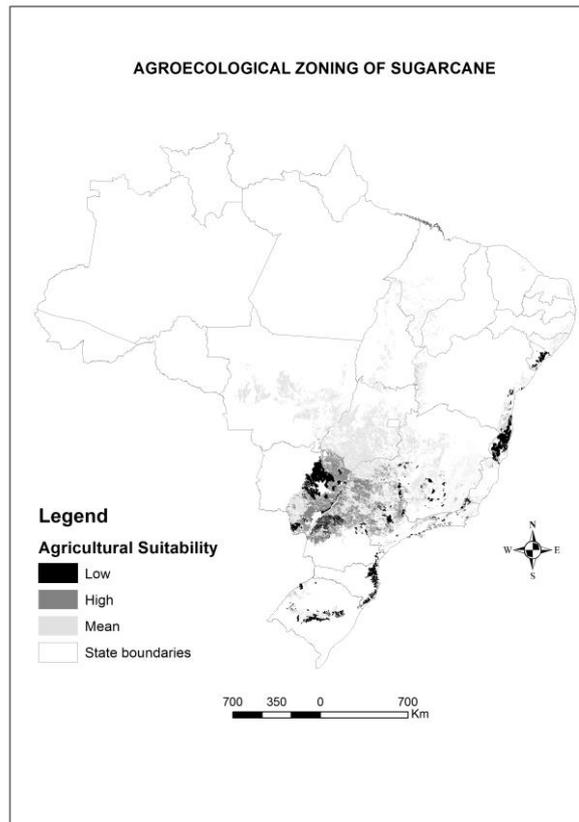
The Brazilian state has actively participated in this project. Most notably, in order to assuage concerns that the expansion of the Brazilian sugarcane frontier was destroying the Amazon

⁸ It is ultimately decided against the idea in the face of industry criticism and doubts over its effectiveness.

⁹ The Logum Logística project has since suffered from the withdrawal of Petrobras, which has turned attention away from the development of ethanol and toward oil – reiterating our earlier point about the close-knit relationship between these two fuels.

rainforest and other sensitive biomes, in 2008 the government established the National Agro-Ecological Zoning of Sugarcane (ZAE Cana) programme. This was designed to identify available/suitable land for sugarcane, and took care to exclude land in the Amazon and Pantanal biomes, land that needed large-scale irrigation, and land that could not be harvested mechanically since otherwise this is burned (Manzatto *et al.* 2009).¹⁰ Cane burning had also been addressed at the state level: in 2002 the São Paulo leadership passed a law requiring its progressive phase-out over the coming years.¹¹

Figure 6: ZAE Cana map of available and appropriate land for sugarcane



Source: Manzatto *et al.* (2009)

Designed by Ralph de Medeiros Albuquerque (Mader-UnB).

At the same time, ZAE Cana has been criticized for not tackling indirect land-use change, not considering the areas for biodiversity conservation put forward by Ministry of Environment, and not establishing restrictions for existing plants or for new projects that have already obtained an environmental license in the excluded areas (Carvalho no date; Pietrafesa and Sauer 2012). Moreover, it has yet to be passed as a law and instead relies on conditions attached to loans and the withholding of milling licenses for compliance. For us, such classifications of ‘available/appropriate’ also remain extremely problematic as they necessarily simplify

¹⁰ The ZAE Cana mapping exercise concluded that Brazil has 64.7 million hectares of total land available for the expansion of sugarcane. Of these 64.7 million hectares, 19.3 million were classified as having high productive potential, 41.2 million with medium potential and 4.3 with low potential. The area of land that was used for pasture in 2002 that is now suitable for sugarcane expansion represents 37.2 million hectares (Manzatto *et al.* 2009).

¹¹ This has been superseded by the Green Protocol, signed by the sugarcane industry and the São Paulo state government in 2007. It establishes a faster phase-out of sugarcane field burning than originally anticipated in the State Law, moving the deadline from 2021 to 2014 for mechanizable areas over 150 hectares, and from 2031 to 2017 for other areas.

complex land relations, ignoring the place of traditional farming practices in the plantation landscape (see Borrás and Franco 2012). The steady destruction of the indigenous Guarani-Kaiowá people in Mato Grosso do Sul and their way of life by the activities of the sugarcane industry bears grim testimony to this (see FIAN 2012). However, what such zoning schemes do demonstrate is the need for legitimacy in such socio-ecological projects, and that this cannot be manufactured by capitalists solely on their own.

Finally, as politically important as those areas where the state *does* intervene are those in which it *does not*. Chief here is the labour regime. One change hastened by sugarcane flexing relates to the redundancy of manual cane-cutters. Since the production of bagasse electricity requires more biomass to be brought to the mill, another incentive is created to move from cane burning to ‘green cane’ harvesting. Because this is more labour-intensive, requiring more strikes of the machete to cut through the leafy and fibrous cane, it tends to be done mechanically, leading to tens of thousands of lay-offs in manual harvesting. In 2006-07 in São Paulo state, 34 per cent of sugarcane area was harvested mechanically; by 2011-12 this had increased to 65 per cent (Raizen 2013). Across the same timescale, and despite the significant increase in output, the number of sugarcane workers declined from 178,000 to 94,000 (CONAB 2014). The fate of redundant workers has largely been left to industry, trade unions and charities to manage through their retraining programme Projeto RenovAção.

Another change in the labour regime relates to inequities in the value chain. Sugarcane growers in the centre-South have complained that the revenue sharing formula which determines the amount they receive for their cane has not been adjusted to account for the increasing profits accruing from electricity co-generation, leaving them with a smaller share of the gains of bio-energy production (McGrath 2013). Following state withdrawal from price control in the 1990s, negotiations over the proportion of exchange value attributable to agricultural production as opposed to industrial processing are, at least in São Paulo, conducted through the institution CONSECANA.

As labour becomes increasingly more subordinate to the needs of capital, unemployed workers and landless peoples displaced from the production process may very well spark new alliances and stronger social movements not uncommon in Brazil. While we have not covered themes of resistance and new alliances across civil society, these are important issues to delve into for future researches, particularly to understand state-society dynamics concerning legitimacy and resistance in the politics of flexing.

Flexing Beyond Brazil: The Cases of Southern Africa and Cambodia

Southern Africa

It's like harvesting nine tonnes of coal per hectare

– Simon Cleasby, Illovo Regional Director, Swaziland Sugar Association annual conference, Mbabane, 2011 (meeting attended by one of the authors)

The production of multiple (non-food) products from sugarcane is most advanced in Brazil, but the dynamics of investment in sugarcane bio-energy and the possibilities this creates for flexing are having broader implications around the world. In Southern Africa, the scale of this process can be gauged with reference to declared revenue by Illovo (2014b), the region's biggest milling group and since 2006 part of the Associated British Foods conglomerate, one of the world's biggest multinational sugar producers. The company's total revenue for 2013-

14 was Rm13.2 billion (US\$ 1.17bn) of which 71 per cent was attributed to sugar production, 22 per cent to cane growing and just 7 per cent to downstream production and energy co-generation – a product mix much more reliant on sugar than in Brazil. Nevertheless, its Chairman Don MacLeod has pledged that “strategic downstream investments will be pursued to enhance and diversify future revenue streams” and a start has been made with respect to its recent investments in co-generation of electricity at its mill in Swaziland, in a distillery for potable ethanol in Tanzania, and in a Memorandum of Understanding with the Zambian government for an ethanol plant to serve the planned domestic fuel market (Illovo 2014b: 29). Similarly Tongaat Hulett – owner of seven mills in the region – has said that it is planning to purchase one power station and that its aspiration over the next decade “is to complete the construction and commissioning of a large scale electricity plant at each of its South African mills and to install at least one large scale bio-ethanol plant at one of its mills” (Tongaat Hulett 2014).

Mirroring our analysis of Brazil, we note again the ambitious (state-orchestrated) plans for sugarcane flexing. For example, in 2014 the South African government launched a ‘Bio-Economy Strategy’ which among other things articulated the need to source second-generation biofuels from woody biomass and sugarcane bagasse. It also highlighted bio-based materials and chemicals as an important growth area, and noted that “owing to the scale of investments needed to establish manufacturing facilities, large sugar and chemical companies are likely to dominate the future industrial biotechnology landscape” (South Africa Department of Science and Technology 2014: 36). Alongside this, other expert authorities like academics have also advanced the need for sugarcane agro-energy, although whereas in Brazil the rhetoric has been dominated by the need for clean domestic energy, in Africa it has been about economic development of the ‘biomass-poverty belt’ (Johnson and Seebaluck 2012). In terms of the investments already made, supportive regulation has again been crucial. An example here would be the Power Purchase Agreements signed by parastatal electricity providers in Mozambique and Swaziland to provide guaranteed prices/demand for bagasse electricity exported from the sugar mills. And similar tensions have also arisen with labour. In South Africa, cane cutters have complained about the move to green cane harvesting as it takes longer to cut and they are paid per tonne; in Swaziland, the Sugarcane Growers Association have threatened to take the millers to court for refusing to share the additional revenues earned on their ‘industrial’ activities.

Cambodia

The 29% drop in our net profit this year compared to the previous year is due mainly to the significant decrease in price of sugar in the world market. However, the performance of our ethanol and biomass energy business is significantly better than that of the previous year. Our ethanol revenue rose from THB316 million to THB603 million while revenue from our biomass energy which we sell to the Electricity Generating Authority of Thailand rose from THB611 million to THB966 million

– Chamroon Chinthammit, CEO of KSL Sugar (KSL Annual Report 2013).

A look into Southeast Asia reveals another vector of expansion, primarily benefitting regional agro-industrial capitalists and their national political brokers. At its heart is Thailand with its transnational sugar companies Mitr Phol, Thai Roong Ruang Sugar Group and Khon Kaen Sugar Industry (KSL). All are now also involved in ethanol and energy production, which as indicated in the quote above, has become a valued diversification strategy for export-dependent companies exposed to market volatility. Mitr Phol, the world’s fifth largest sugar producer also

refers to itself as Asia's biggest bioenergy producer. Its subsidiary Mitr Phol Bio-Fuel Co. has four ethanol plants in Thailand with a total capacity of 890,000 liters per day – benefitting from the Thai government's National Biotechnology Policy Framework, in place since 2004.¹² Through Panel Plus, another Mitr Phol subsidiary, the company has also become a leading manufacturer of 'wood substitute materials' from bagasse and rubberwood chips (Mitr Phol website). Mitr Phol is a member of the Thai Bioplastic Industries Association and sells carbon credits to Thai Airways.

Looking to expand within the Greater Mekong Subregion,¹³ Mitr Phol and KSL Sugar have become dominant players in the sudden and controversial creation of a Cambodian sugarcane complex. This complex has been based on three state-backed land concessions all of which have been connected with severe human rights and labour rights abuses (see Equitable Cambodia and Inclusive Development International 2013; FIAN 2014). Concessions in Oddar Meanchey totaling almost 20,000 hectares are controlled by Mitr Phol while 70 per cent of the concessions in Koh Kong (19,000 hectares) are held by KSL Sugar. The third set of concessions in Kampong Speu (24,000 hectares) are majority owned by the company of a Cambodian ruling party senator, Ly Yong Phat, although the sugar mill has been built by the Thai company SU-ENCO, which also delivers factory technology to Mitr Phol.¹⁴

Mitr Phol also has strong ties to China operating seven sugar mills in Guangxi province, but at the same time, and illustrating the regional dynamics at work, Chinese-based capital is investing in sugarcane plantations and factory in Cambodia. In Preah Vihar province, five side-by-side concessions have been granted to five Chinese-controlled companies, together totaling more than 40,000 hectares of land. The FAO data in Table 1 referring to 28,500 hectares under sugarcane cultivation in Cambodia thus does not capture the full extent of the dislocation already underway in Cambodia because of sugarcane concessions.¹⁵ It is in fact estimated that the government has already granted Economic Land Concessions for sugarcane totaling more than 100,000 hectares, giving the material basis for making sugarcane flexing possible (Borras *et al*, 2015).

Since 2009 Least Developed Countries like Cambodia have been able to export sugar tariff and quota free to the EU market, which, despite reform, still offers prices above the world market price. Because of this trade initiative, called 'Everything but Arms', virtually all sugar exported from Cambodia is heading for Europe, initially processed in Tate & Lyle's refineries but now in Bulgaria and Romania too. While the gap between EU and world market prices is expected to narrow due to further domestic liberalization of EU sugar policy effective from 2017, almost ten years of substantive economic incentives has undoubtedly underpinned the formation of a sugarcane industry in Cambodia. Investments have taken place in Laos for similar reasons, and indeed in Southern Africa, where Mozambique and Zambia among others also qualify for Everything But Arms status.

¹² Phase I was between 2004 and 2011, Phase II between 2012 and 2021. The frameworks are to encourage in developing biobusiness and investment in biotechnology research. Among the six goals of the framework are "Emergence and Development of New Bio-Business", "Utilization of Biotechnology to Conserve the Environment and to Produce Clean Energy" and "Biotechnology as the Key Factor for Self-Sufficient Economy". In 2007 the government funded biotechnology research with US\$120 million (Waramit 2012).

¹³ The Greater Mekong Subregion is: Cambodia, Yunnan Province and Guangxi Zhuang Autonomous Region of China, Laos, Myanmar, Thailand and Viet Nam.

¹⁴ Ly Yong Phat also held shares in the Koh Kong concessions until 2010.

¹⁵ Even the FAO data being underestimated, they show an amazing expansion of sugarcane plantations in Cambodia in a decade period, highlighting the growing interest and investment in the sector in the region.

Anticipating attenuating returns from sugar exports, attention is now turning to marketing sugarcane's other products. In April 2014 Phnom Penh-based Smart International Consulting, which offers services on agricultural land acquisition, presented an investment project together with an unnamed international investor for sugarcane flexing in Cambodia. Their presentation suggests that the project had already secured 5,000 hectares of land in Pursat Province. In their investment plan they explain: "The sugar refinery and bio-ethanol plant investment project in Cambodia is motivated by [...] the high demand on the international market for refined sugar and bio-ethanol". They also highlight that "The project will benefit from 8 years Income Tax Exoneration" and a Foreign Direct Investment License to be applied will grant "free import tax and free corporation tax for a period up to 9 years". Once again we see the importance of state policy, although suggest that unlike in Brazil, where industry support is exercised in a more bureaucratic form in Cambodia we see a much more patrimonial style of intervention.

Conclusions

In their prescient book on the capitalist penetration of agriculture, Goodman *et al.* (1987) noted how capitalists seek to reduce the agricultural product to basic constituent ingredients amenable for use as industrial inputs. They called this process 'substitutionism' and argued that it would lead to 'integrated biomass production systems' freed from the constraints of pre-determined product and marketing channels as crops could be turned into a variety of interchangeable inputs. This, in turn, would result in a rising proportion of value accounted for by industrial capital and the elimination of the quintessential rural base of agriculture. What we see unfolding via sugarcane flexing in Brazil, Southern Africa and Cambodia is an extension of this process, with the crop used to substitute for fossil-fuel based products like gasoline and plastic. The accrual of wealth to industrial capital is also hinted at in the recent declaration of Rubens Ometto Silveira Mello, Chairman of Cosan, as the world's 'first ethanol billionaire' in the Forbes magazine rich list. Meanwhile, the increased control and industrialisation of sugarcane production by these same actors, along with the steady strangulation of rural and indigenous communities marginalized by its expansion, indicates the incompatibility of mechanised monocrop flexing with traditional agrarian livelihoods.

Yet as much as such developments might be impelled by the logic of capital accumulation, they are also beholden to politics. In this paper we have focused on politicising the commodification and commercialization of sugarcane by bringing in the state. On the one hand, we identified various forms of industrial policy – consumption mandates, tax breaks, research and development support, trade politics, and, most importantly, credit provision – as ways in which the state has underpinned the transforming of the sugarcane milling industry into a multi-functional raw materials supplier. As in other cases of technological innovation and structural economic transformation, public institutions and funding will continue to be essential to the construction of a 'green' or 'bio-economy' too. On the other hand, we located some of the distinctive tensions raised by sugarcane flexing and thereby rejected the blithe assessments of this as a 'win-win' strategy. These included questions over consumer prices for fuel, control of distribution infrastructure and conditions and implications of land control and conversion – areas in which the state has actively intervened, and not always in the interests of industrial capital. In other words, the state remains a vital site for the contestation of, as well as support for, sugarcane flexing.

While this preliminary study hopes to contribute to further analyses on flex crops and commodities, we point to three lines of enquiry for future academic research:

First, it is important to consider the extent to which flexing is eroding the distinction between crop regimes. Due to the substitutability of final products (e.g. sugarcane or maize-based ethanol in the US; ethanol or gasoline in Brazil) flexing has further eroded the functional distinction between particular crop regimes, and even between agricultural resources and fossil-fuel resources. One result, as reported by analysts at the Intercontinental Exchange, the world's major soft commodities trading group, is that the prices of sugar, corn, ethanol and gasoline are becoming more tightly correlated in international markets (ICE 2012). Higher prices for oil and other fossil fuels no longer just affect the cost of fertilisers and running farm machinery; they also encourage sugarcane millers (particularly those in Brazil) to produce more ethanol and less sugar, putting a second inflationary pressure on the world price of sugar. To this extent, controlling food price inflation might thus become increasingly contingent on controversial oil extractions. In addition research is needed on the link between flexing and food security (in our Brazilian case, attention was very much focused on the wage-good of fuel rather than food). Based on market signals, investors might shift vast amounts of crops from food to fuel markets (and vice versa) within days. In turn, this could have substantive implications for food availability and accessibility, as well as inducing deepening financialisation as market actors seek to manage or speculate on price volatility.

Going further, the erosion of distinct crop regimes might be accelerated by the emergence of flex-fuel power stations that can alternate between natural gas and sugarcane ethanol (e.g. the joint venture in Brazil between US-based General Electric and Petrobrás) and flex-crop ethanol facilities that can alternate between maize and sugarcane (e.g. the Usimat facility in Mato Grosso, also in Brazil). These are likely to make primary processing increasingly independent from specific supply bases, allowing for continuous production (e.g. synching the sugarcane harvest with the maize harvest to create a year-round crush) and a greater degree of locational autonomy. Yet at the same time, at the systemic level, it also creates additional web-like links between the major fungible crops and fossil fuels, which are essentially turned into interchangeable forms of living/dead 'biomass'.

Second, pinpointing where the decision-making lies for flex oriented investments and production will help us understand underlying drivers, actors, and state-capital relationships. The integration between sugarcane millers and oil producers at a corporate level for us raises questions about the changing nature of company decision-making. For example, managers at BP, Petrobras and Shell might be expected to push for greater ethanol production within the sugarcane mills, even if relative prices would suggest that more sugar be produced. Alongside new management structures, the locus of power in global agriculture might also be moved by changes in ownership. The boom-and-bust dynamics of the sugarcane industry, heavily influenced by the financing demands of flexing, have ousted many of the traditional plantation-owning families and cooperative milling groups in favour of publicly traded corporations funded by shareholder equity.¹⁶ Might this lead to different organizational imperatives and approaches to sugarcane production? Finally at the sectoral-level, the trend toward monopolization poses important questions not just about the concentration of economic power and potential for rent-seeking, but also about the concentration of political power and changes in the state-market relationship.

Lastly, on what basis do state actors support sugarcane flexing and the bio-refinery concept? We touched on various possible reasons in this paper. These included: belief in the 'bio-

¹⁶ The decision to turn Copersucar from a cooperative into a corporation was linked to the need to raise extra capital to fund the groups expansion (see DataMark 2008).

economy' as a general capitalist fix; narratives of flexing as a renewed and renewable mode of accumulation for the sugarcane sector specifically; lobbying by the agro-industrial fraction of capital and its suppliers; attempts to deliver environmentally-friendly energy or rural development; the bureaucratic interests of particular state ministries or agencies; and the pecuniary interests of politicians with a financial stake in such projects. These need not be mutually exclusive, but it is important to distinguish in what contexts these combine and become significant in order that they might be put under greater scrutiny. The development and expansion of a flex crop and commodities regime requires recasting and re-tooling traditional theoretical approaches of agrarian political economy to encompass the broader interests, relations, and actors involved in the dynamics of flexing. While these issues require much deeper empirical-based investigations, we hope this preliminary analysis of the political economy of sugarcane flexing sparks new interest and debate in researching this area.

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Ben McKay is a PhD candidate at the International Institute of Social Studies (ISS) in The Hague, and is part of the research programme Political Economy of Resources, Environment and Populations Studies. He is currently researching agrarian transformation in Bolivia in the context of the ‘soy complex’ and the rise of BRICS (Brazil, Russia, India, China, South Africa) countries. Email: mckay@iss.nl

Sérgio Sauer has a PhD in Sociology and is Professor at the University of Brasília at the Planaltina campus (FUP/UnB) in the Post-Graduation Program on Environment and Rural Development (Mader). He is currently a Visiting Professor at the International Institute of Social Studies (ISS) in The Hague and his Postdoctoral research is on land grabbing with a grant from CAPES-Brazil. His research is mainly on land struggles and territory rights, agrarian social movements, land policies, expansion of agrofuels and food sovereignty in Brazil.

Ben Richardson is Associate Professor in International Political Economy in the Department of Politics and International Studies at the University of Warwick. His research is on the political economy of trade and development with a focus on sugar and biofuels. He is the author of the forthcoming book *Sugar* in the Polity Resources series. Email: b.j.richardson@warwick.ac.uk

Roman Herre has an M.A. in geography (minoring ethnology). He is working for the German section of the international human rights organisation FIAN. His main work area includes the human right to food, land conflicts and development cooperation. Among other countries he is working on land conflicts and human rights violations in the context of sugar cane expansion in Cambodia. Email: r.herre@fian.de