

# Modern Monoculture and Periphery Processes: a World Systems Analysis of the Brazilian soy expansion from 2000-2012<sup>1</sup>

Niels Soendergaard<sup>2</sup>

**Abstract:** *The article treats the broader socio-environmental and economic implications of the expansion in Brazilian soy production, during the period from 2000-2012. The World Systems Analysis (WSA) perspective of Terence Hopkins and Immanuel Wallerstein (1982) is applied in order to assess whether this development may be understood as characteristic of the economic processes of periphery formation. This theoretical framework is combined with contemporary contributions to the World Systems Analysis literature that emphasize environmental issues and the particular nature of modern agribusiness, in order to grasp the complexities of today's Brazilian soy sector. The dynamics of production expansion and its different societal impacts are approached through a commodity chain analysis of the Brazilian soy production. A data triangulation strategy is applied within the analysis, through scrutiny of official documents, research papers, interviews and statistical material. The article concludes that while some circumstances diverge from the interpretations of the WSA perspective, other findings suggest a convergence between the recent Brazilian soy expansion and this theoretical body's conceptualizations of global periphery. The analysis also points to the need to reconsider the structural determinism of the WSA perspective, particularly with regards to the possible potential of political agency to confront the challenges associated with commodity-based development.*

**Key-words:** *commodity markets, farming, land tenure, agribusiness, sustainability.*

**Resumo:** O artigo trata das implicações socioambientais e econômicas da expansão da produção de soja brasileira, durante o período entre 2000 e 2012. A perspectiva de análise de sistema mundo de Terence Hopkins e Immanuel Wallerstein (1982) é aplicada para avaliar em qual medida este desenvolvimento pode ser entendido como sendo característico do processo econômico de formação de periferia. Este arcabouço teórico é combinado com contribuições contemporâneas na literatura de Análise de Sistema Mundo que enfatizam assuntos ambientais e a natureza particular do agronegócio moderno, com a finalidade de entender as complexidades do atual setor de soja brasileiro. As dinâmicas de expansão produtiva e as suas diferentes implicações na sociedade são abordadas por meio de uma análise de cadeia de commodity da produção brasileira de soja. Uma estratégia de triangulação de dados é aplicada na análise, por meio de exame de documentos oficiais,

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2. Doutorando no Instituto de Relações Internacionais, Universidade de Brasília, Distrito Federal, Brasil. E-mail: niels@soendergard.dk

pesquisas, entrevistas e material estatístico. O artigo conclui que enquanto algumas circunstâncias divergem das interpretações da perspectiva de Análise de Sistema Mundo, outros achados sugerem uma convergência entre a recente expansão da soja brasileira e as conceitualizações deste corpo teórico sobre periferia. A análise também aponta para a necessidade de reconsiderar o determinismo estrutural da perspectiva de Análise de Sistema Mundo, particularmente com relação ao possível potencial de agência política para confrontar os desafios associados com o desenvolvimento baseado em commodities.

**Palavras-chaves:** mercados de commodities, cultivo, posse da terra, agronegócio, sustentabilidade.

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## 1. Introduction

The goal in the following article is to evaluate how the expansion of soy production within Brazil in the beginning of the 21st century may be associated with processes characteristic of the notion of 'periphery', as conceptualized within the World Systems Analysis perspective. The notion of periphery is treated in the work of Terence Hopkins and Immanuel Wallerstein (1982), within which it is presented as internally constituted by four essential periphery conditions, related to the processes of incorporation, concentration of production processes, conversion of labor power and simple reproduction. In order to understand the contemporary dynamics of soy expansion within Brazil, these classical World Systems Analysis perspectives have been coupled with some more recent conceptualizations within this body of theory that treat the role of modern agriculture within the world economy.

The paper's methodological approach is based on a Global Commodity Chain analysis, which is applied in order to examine the consequences of soy expansion at the length of the soy chain. This method is relied upon in order to evaluate the diverse environmental, social and economic implications of this development, through a specific focus on the productive and distributional structure for soy within Brazil. The study's empirical foundation is constituted by a triangulation of data, consisting of expert interviews, public documents, statistical databases, news media and academic articles.

The article concludes by identifying the emergence of some significant features of periphery

conditions related to the Brazilian soy expansion, particularly when the incorporation of environmental recourses are considered. This also becomes apparent through the lens of more recent contributions to the WSA framework, with focus on ecologically unequal exchange, food sovereignty, and corporate agriculture, which reveals a series of complex socioeconomic and environmental ramifications of the Brazilian soy boom. Yet, the mode of modern soy production in Brazil does also seem to imply some characteristics which escape Hopkins and Wallerstein's notion of periphery. These are mainly related to the high degree of technological content of soy cultivation, and a certain degree of agro-industrial economic spin-off, and growth of income in soy-producing regions. The article thereby also points to the need to rethink the notion of periphery in relation to modern agro-industrial development, and to adjust the structuralist approach to more closely engage with issues related to the particularities of modern commodity-based development.

## 2. World Systems Analysis and the periphery

The conceptualizations of periphery and semi-periphery within this article are derived from the World Systems Analysis (WSA) perspective. Though the wording of periphery implies geographical connotations, the concept mainly refers to the workings of productive processes interrelated with the world economy, within a given area: a dominance of peripheral processes – related to certain periphery conditions – defines the given place where they

unfold as periphery or semi-periphery (HOPKINS and WALLERSTEIN, 1982, p. 13). Periphery processes are intrinsically intertwined with the mode of production and its spread effects upon society. The core specializes in capital-intensive and high technology production, peripheral regions specialize mainly in agriculture or recourse extraction, while semi-periphery refers to regions that are characterized by a relatively equal mix between these two types of productive activities (IBID, 1982, p. 59). Peripheries develop parallel to cores, and can only be understood in their relation to core areas, because they occupy a necessary position within the axially structured division of labor of the world economy (IBID, p. 125).

Hopkins and Wallerstein divide the notion of periphery into four fundamental patterns, encapsulated in the concepts of periphery conditions: 1) *Incorporation*, which implies that the production processes are adapted to the needs of the world economy and inserted within an axial division of labor. Governance processes are similarly integrated within, and subjugated to the needs of global market structures. 2) *Concentration of production processes*, leading to a very limited range of products being produced, and mainly for consumption of core industries or domestic households. 3) *Conversion of labor power*, into labor-in-relation-to-capital and particularly low wage labor, in primary sectors, living on a subsistence minimum. 4) *Simple reproduction*, both of capital and inputs into the production process, sometimes implying a scalar expansion, though without any significant technological improvements associated with this (HOPKINS and WALLERSTEIN, 1982, p. 126). These four groups of periphery conditions are scrutinized in the following parts, where each is connected with some more specific indicators derived from the WSA literature.

### 3. Incorporation

Incorporation refers to the process through which an area or a social group is structurally incorporated into the world economy. This process both implies a geographical dimension of expansion of the world economy to new regions of the world, but also a classifying dimension in which the newly incorporated areas are inserted into the global axial division of labor

(HOPKINS and WALLERSTEIN, 1982, p. 126). Local production processes and governance structures are integrated into the world economy, and structured towards the supply of products required in core production (Ibid, 1982, p. 129).

Thomas Hall has elaborated on the notion of incorporation and underlines that it is a process that often wields a detrimental impact on the regions/peoples incorporated, provokes resistance, and usually tends to unfold as a self-enforcing one-way trajectory (HALL, 2012, p. 48). Gereau and Borrego also emphasize how this process of expansion has become an integral part of modern cash-crop farming, as the constant search for yields lead agribusiness to expand its production systems worldwide, but also to unsustainably intensify production (GEREAU and BORREGO, 2012, p. 358). A basic condition for the expansion of industrialized agriculture in peripheral regions has been the large inputs of pesticides, herbicides, fungicides and fertilizers (IBID, 2012, p. 357). This both entails the degradation of soil and biodiversity loss, but is likewise associated with a model of petro-dependent agriculture that also relies on the input of patented biotechnology. Thereby, the principle of incorporation also comes to comprise of the incorporation – and eventual exhaustion – of resources such as soil fertility and naturally occurring water reserves, into the production process (IBID, 2012, p. 359).

The indicators derived from the general concept of incorporation for further examination in the analysis are therefore; the environmental effects of soil degradation and agrochemical usage considered as the incorporation of soil quality into production, and the biosphere loss due to deforestation of land areas. The degree of foreign control of soy production processes and level of penetration of transnational capital shaping production processes are likewise considered.

### 4. Concentration of production processes

A fundamental periphery condition has to do with the production processes of a region or country being concentrated on a very short range of activities, as part of the division of labor within the world economy. These activities are primarily directed towards

generating goods for sale on the world market and meeting the demands of core economies (HOPKINS and WALLERSTEIN, 1982, p. 126).

The increasing specialization of agriculture in the direction of export-oriented monoculture and the many-folded implications of this mode of production have been examined by contemporary WSA scholars. Especially the high degree of capital intensity, combined with global tendencies of liberalization of agriculture, is often highly related to the displacement of smaller agricultural production units (GEREAU and BORREGO, 2012, p. 359). Scanlan similarly underlines how large-scale specialized agriculture is associated with a market-focused distribution, which may hold negative consequences for local food security (SCANLAN, 2012, p. 369). The conglomeration of agriculture thus comes to constitute a cluster of intertwined issues regarding food sovereignty, land access, and biodiversity loss due to monoculture (Ibid, 2012, p. 370). In this respect, Gereau and Borrego underline how the tendency that they refer to as *the neoliberal shift in agriculture* has produced a governance structure that is largely inconsiderate of the needs of local rural populations, particularly regarding food production (GEREAU and BORREGO, 2012, p. 359).

These observations lead to the inclusion of arable land inputs, in terms of local land access and food security, along with trends of corporate conglomeration as indicators of concentration of production processes.

## 5. Conversion of labor power

The conversion of workers into labor-in-relation-to-capital, also exemplified by Hopkins and Wallerstein as low wage plantation field hands, has also been stated by these authors as one of the main periphery conditions. Workers are inserted within an economic system, in which they live on a subsistence minimum, which only reaches a wage level needed in order to reproduce their labor power (HOPKINS and WALLERSTEIN, 1982, p. 126). Scanlan refers to the expansion of modern agriculture as *proletarianization* of the rural labor force; displacing it from small scale production and reincorporating it into the plantation economies as low wage labor (SCANLAN, 2012, p. 370). Gereau and Borrego also state that within conventional capitalist agriculture, the need to increase yields also comes to

rely on labor inputs as a recourse, which can be fully exploited to the point that it debilitates this factor, with detrimental health consequences being internalized by workers (GEREAU and BORREGO, 2012, p. 357).

This points towards the relevance of examining labor inputs in Brazilian soy production below the indicators of labor conditions and rural employment.

## 6. Simple reproduction

Simple reproduction refers to the reproduction of capital, according to Wallerstein and Hopkins, only being realized in a simple fashion with equipment maintained or replaced and stocks replenished. This also implies that the organic composition of capital and the technical level of production and organization of production largely remain at a constant, stagnant, level. Furthermore, whenever technical innovations and organizational improvements of production occur, this implies very limited structural ramifications within the surrounding economy (HOPKINS and WALLERSTEIN, 1982, p. 127).

As the notion of simple reproduction is conceptualized by Hopkins and Wallerstein, it does appear to diverge to some degree from the way modern agriculture is presented by WSA scholars in contemporary intermediate theorizing. Technical and organizational development is central to both Gereau and Borrego (2012) and Scanlan (2012). Though capital-intensive agriculture does indisputably appear to be characterized by dynamic technical and managerial developments, the question still remains as to what degree these imply structural ramifications and spill over into the broader economy.

Concomitantly, the indicators connected to the concept of simple reproduction are defined as the lack of domestic soy processing capacity and productive links to the broader economy. The question of the creation of a research and development (R&D) complex associated with soy production and with links to the domestic economy are similarly considered.

## 7. Global Commodity Chain Analysis

The concept of commodity chains is derived from the WSA literature, but it has also given rise

to an independent analytical approach, the global commodity chain (GCC) analysis, which is employed in order to analyze the expansion of the Brazilian soy frontiers. The relevance of a specific focus upon commodity chains has also been emphasized by Hopkins and Wallerstein (HOPKINS and WALLERSTEIN, 1982, p. 59).

Commodity chains become an essential object of analysis within WSA research, due to their significance in defining hierarchies within the world economy, and because they connect global production systems to the social reproduction of labor (BAIR, 2005, p. 155). This entails an analysis of the social division of labor along the lines of geographical division of labor (PARNREITER, 2012, p. 235). The focus upon commodity chains also becomes relevant in order to understand how productive processes affect the environment, and thereby produce what Ciccantell and Smith refer to as 'ecological inequalities', which is an increasingly important dimension to consider below the notion of periphery (CICCANTELL and SMITH, 2009, p. 363). Ciccantell and Smith state that GCC analysis can be a useful extension to classic WSA analysis in order to understand more contemporary issues of *ecologically unequal exchange* (IBID, p. 364). Though many GCC studies have often focused upon commodity chains from the beginning of manufacturing, Ciccantell and Smith sustain that the examination of the upstream point of raw material production should not be neglected, when evaluating worker conditions and environment effects (IBID, p. 362).

Generative sectors also play an important role in the analysis of commodity chains through a WSA perspective, due to their role in capital accumulation and surplus distribution along the chain (BAIR, 2005, p. 158). These sectors are also closely connected with the raw material stage, linking this product stage with further processing through the commodity chains as one of the first steps in this process. Generative sectors, apart from representing a step beyond the exclusive extraction stage of a product, may also provide spread effects and costs reduction throughout the economy (CICCANTELL, 2012, p. 385). Thereby, they provide both backward and forward links, but also produce technical knowhow, foster specialists and stimulate knowledge-based institutions. They furthermore entail the creation of both informal and formal ties between sectors, enterprises and the political level, and affect

the legal provisions regulating the area (CICCANTELL and SMITH, 2009, p. 369).

In spite of commodity chains stretching across nation state boundaries, this unit also often holds some significance in defining the functioning of the production chains and in regulating the conditions below which different actors operate (PARNREITER, 2012, p. 236). This points towards the relevance of examining the role of the political level in establishing the institutional context for the function of commodity chains. Bair also sustains that analysis of the governance structure of a commodity chain implies some important insights about the questions of ownership, control and value distribution, the intra-firm networks and hierarchical structures, as well as the producer or buyer driven dynamics of the chain (BAIR, 2005, p. 159).

As a more specified procedure for embarking on GCC analysis, Bair points to some dimensions that may serve as a starting point. The mapping and general structure for examination of the soy commodity chain is based on those dimensions indicated below:

- **The structure of inputs and outputs** – including a strong emphasis on environmental and labor inputs in the beginning of the chain and the exchange relations at the point of export.
- **The territoriality of the commodity chain** – mapping the links from the point of inputs through processing towards export.
- **The governance structure of the chain** – regarding relations of ownership and control, value distribution and buyer/producer driven dynamics (BAIR, 2005, p. 159).

## 8. Methodological approach

The objective within the following is to examine the developments within different links of the Brazilian soy commodity chain from 2000-2012, in order to trace the possible emergence of periphery conditions, earlier conceptualized in the reviewed WSA literature. Attention is directed towards the evolution of periphery conditions dynamically *through* the time period, and not as a static "snapshot" documenting their possible presence in the soy commodity chain at some point within the period. Though the soy commodity chain transgresses state boundaries, attention within this

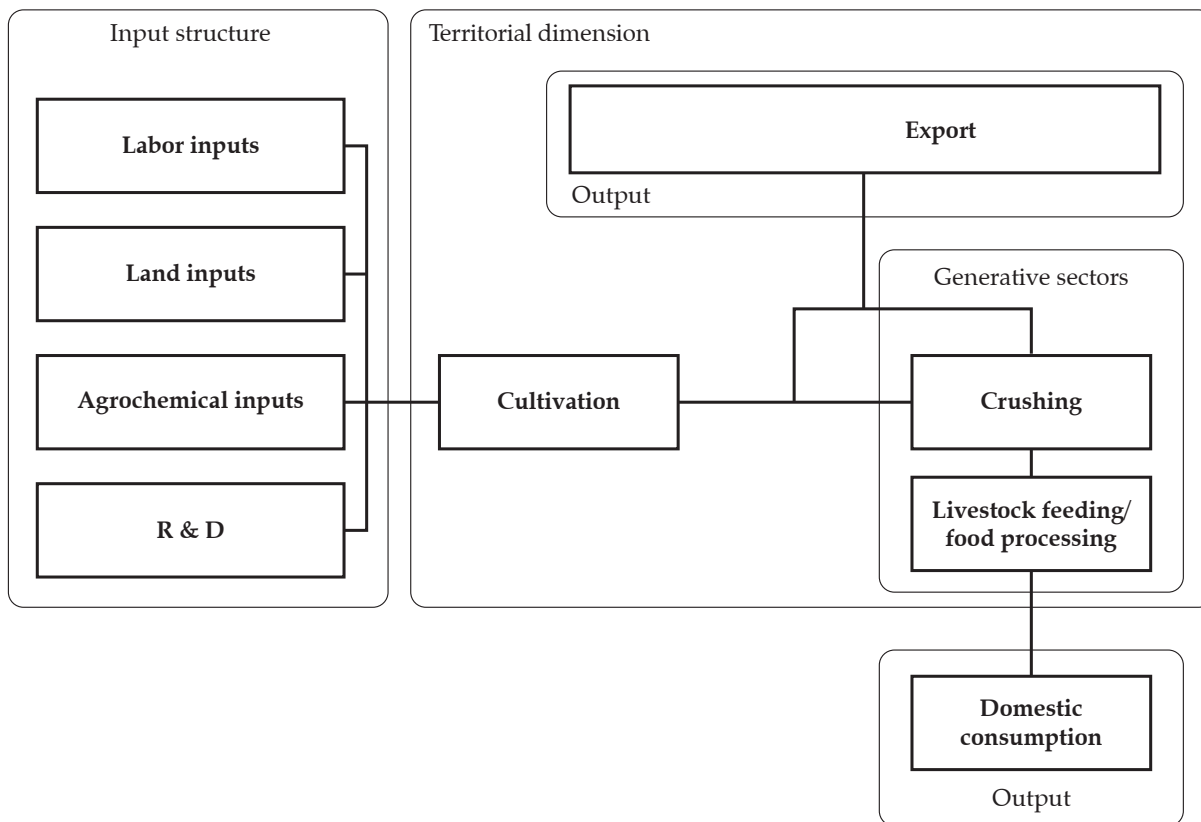
analysis is restricted to the Brazilian part of the chain, because the domestic consequences of expansion are the focal point. The goal is to trace the evolution of periphery conditions to the dynamics of expansion of the Brazilian soy commodity chain, and not those circumstances that are more generally embedded within Brazilian agriculture. Though this distinction may be blurred in some instances, it nevertheless constitutes a central aim and parameter for later conclusions. A map of the Brazilian part of the soy chain, intending to grasp the dimensions treated in the GCC literature as those of, 1) input/output structure and 2) territoriality, is presented in Model 1.

The indicators pertaining to the concept of periphery conditions are examined within the chain. As result of the earlier operationalization, indicators related to *incorporation* and *concentration of production processes* are sought within the category of land and agrochemical inputs, *conversion of labor* within labor inputs and *simple reproduction* within the categories of

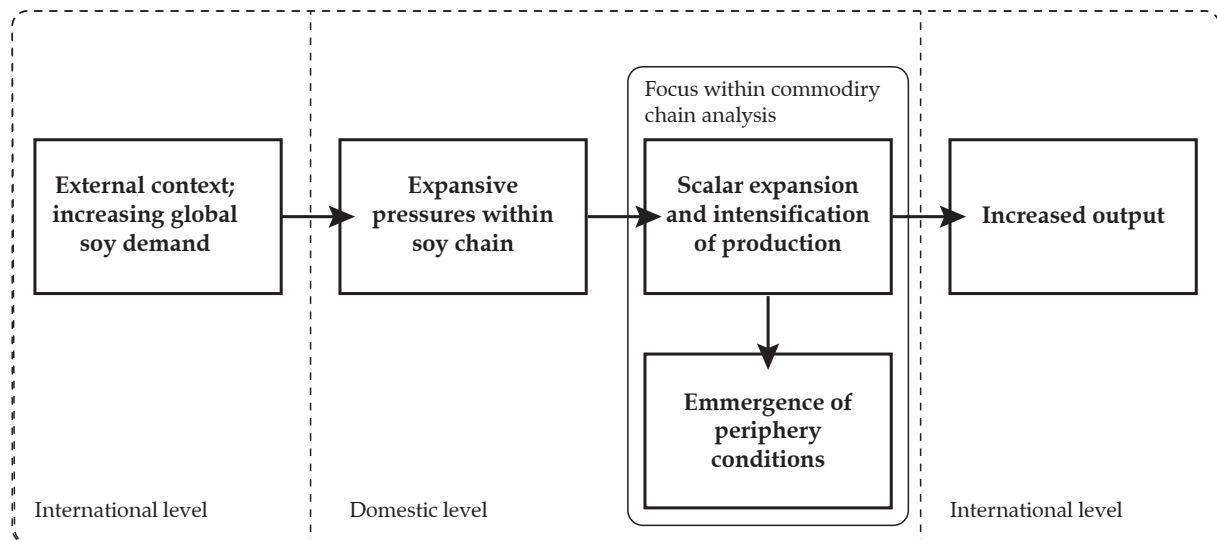
R&D inputs and generative sectors. The way that the governance structure of the commodity chain becomes relevant with regards to the issue of periphery conditions is evaluated along the analysis at instances when the question arises.

Many indicators of socioeconomic and environmental character are expected to have been affected by developments within the input structure serving as basis for soy cultivation, which is why this part of the commodity chain has been strongly emphasized. These links within the chain thus constitute general subject categories, which are examined from 2000-2012 with an eye to the development of the indicators of periphery conditions within this period. It is presumed that the pressures for expansion are transferred from the international to the domestic market, and that periphery conditions thus are derived from the many-folded impacts of the process of expansion, which affects all links within the chain. A model of this relationship is presented in Model 2.

**Model 1.** A mapping of the Brazilian soy commodity chain



Source: Author’s elaboration.

**Model 2.** Expansion within the soy commodity chain and the emergence of periphery conditions

Source: Author's elaboration.

The empirical basis of the study is constituted by a triangulation of data, comprising of secondary literature, documents and statistic material primarily from public Brazilian institutions, but also from private research foundations and NGO reports. A small number of interviews have also been conducted with specialists engaged with agriculture and development in Brazil, employed in national/international service and within the NGO community.

## 9. Analysis of the soy commodity chain

The analysis of the soy commodity chain is aimed at understanding the evolution of indicators pertaining to the concept of periphery conditions from 2000 to 2012. The analysis is structured in order to focus upon each stage of the commodity chain, at which the expansionary dynamics and their repercussions are evaluated.

## 10. Land inputs

Land inputs for the expansion of soybean production can be analyzed either in relation to the issue of land arable access and food sovereignty, or in terms of the environmental implications of this development. The following analysis therefore initially directs focus towards the general issue of land distribution, and subsequently towards the environmental dimension.

Privately owned land in Brazil is characterized by a markedly unequal distribution. Table 1 below illustrates how the large group of small properties below 10 hectares, constituting nearly half of all rural properties, only accounts for 2.36% of private land holdings, while the marginal group of properties above 1000 hectares, owns 44.42%.

The rural Gini coefficient, referring to inequality of land distribution, has likewise increased from 0,857

**Table 1.** Extend and distribution of rural property

	Percentage of registered properties	Total area of the properties (hectares)
Less than 10 hectares	47.86%	2.36%
10 to 100 hectares	38.09%	19.06%
100 to 1000 hectares	8.21%	34.16%
1000 + hectares	0.91%	44.42%

Source: IBGE (2006).

to 0,872, in the period 1995-2006; meaning an increased inequality in land distribution during the period (IBGE, 2006). The Brazilian Institute for Geography and Economics ascribes much of the increase in land concentration to the surge in export-oriented farming - and soy in particular, - the expansion of the agricultural frontiers, and the professionalization of agriculture (FOLHA, 2009). The two later factors have also constituted marked tendencies within the expansion of the soy complex, and have thus become intrinsically linked to this development. An interviewee also draws a more direct connection between soy expansion and land concentration, through what is characterized as an ever stronger tendency of land concentration, due to the very efficient mode of production of modern soy cultivation. Thereby, agricultural reforms pushing many smallholders out of business in the 1990s (RODRIGUES, 2001, p. 7) have been working in conjunction with the emergence of an extremely efficient large-scale monoculture as soy production, to increase land inequality through expansion of this sector. According to Helfand *et al.* (2011), limited land access constitutes one of the central components that is determinative of rural poverty in Brazil, which raises the question of whether large-scale industrial agriculture may be compatible with the improvement of standards of living amongst smallholders in regions of soy expansion.

In terms of crop distribution and food access, the increasing concentration of land on soy production also poses some questions about diversity of food production and local food security. Family based agriculture is a particularly essential source of local food supply, because of its more diversified output of basic foodstuffs such as manioc, beans, wheat, corn and rice. Reviewing the overall figures for crop distribution, a noticeable decrease in the area sown with rice and beans can be observed during the period of rapid soy expansion from 2000-2010 (See Table 2 below).

Apart from a marked increase in wheat production, the extend of the area dedicated to the cultivation of corn and manioc has largely remained constant, while a rapid increase in soy cultivation can be observed, indicating that soy expansion has been accounting for most new land incorporated for agricultural production from 2000-2010. The fall in the area sown with rice and beans and the increasing relative weight of the area dedicated to soy cultivation, from 26% of total cultivated area in 2001 to 39% in 2010 (IBGE, 2013), does raise some questions about the diversification of agricultural production, though gains in productivity are not accounted for here. In spite of increases in yields per hectare, Correa (2013) thus finds that from 1990-2009, 60% of the increases in soy production was due to scalar expansion, which to a significant extend incorporated areas previously occupied by rice and bean production (CORREA, 2013).

Some of the interviewee's stress that in Northern Brazil, pressures to remain competitive have made smallholders prioritize cash crops such as soy, at the costs of locally consumed crops, or to sell their properties to soy farmers. The interviewees also encountered tendencies of pest transfer, occurring when the use of pesticides on soy fields led to an abnormally high concentration of insects on locally consumed beans. Another interviewee emphasizes that in some parts of the Cerrado region, up to some 90% of basic foodstuffs are imported, which has led to higher prices and wielded a disproportionate impact upon low-income families. This is partly ascribed to a bias against smallholder agriculture at the local political level, which often is dominated by large scale export-agriculture, meaning that federal local food support programs are poorly implemented by municipalities and states. This indicates that the issue of food security in relation to soy expansion also may depend much on the specific geographical and local political context in the soy frontiers.

**Table 2.** Hectares sown with main crops in Brazil

	2000	2010
Rice	3.664.804	2.722.459
Beans	4.332.545	3.423.646
Manioc	1.709.315	1.787.467
Corn	11.890.376	12.703.373
Wheat	1.138.687	2.181.567
Soy	13.656.771	23.327.296

Source: IBGE (2006).



In effect of the high degree of concentration of agricultural production on the cultivation of soy – a production process strongly oriented towards meeting the needs of external markets – an increasing part of the Brazilian economy and territory has been inserted into the international division of labor through specialized primary production. So, with the expansion of this sector from 2000 and the rises in inequality of land distribution, a high degree of concentration of production processes – as conceptualized by Hopkins and Wallerstein (1982) – can be identified as a strong trend within part of contemporary Brazilian agricultural development.

This circumstance, *per se*, is often negatively perceived by “classical” WSA scholars, due to a bias against large scale export-oriented primary production. Yet, contemporary WSA perspectives such as Scanlan (2012) and Gereau and Borrego (2012) tend to focus more upon the problematic effects of this mode of production in relation to a range of more specific issues. In this regard, the impact on food access seems to differ from region to region, yet, on a national level the growing relative share of area dedicated to soy production does indicate some trends of cash-crop concentration. In summary, the growing land inputs to the cultivation of soy production from 2000-2012, by exacerbating land tenure inequality and instances of foodstuffs scarcity, does seem to accentuate the increased presence of the periphery condition of concentration of production processes.

With regards to the environmental dimension of soy production, the bulk of the newly incorporated territory has been territory previously occupied by native vegetation, and mainly in the vast inland Cerrado Savannah-like areas (NASSAR and ANTONIAZZI, 2011, p. 5). From previously being an unfertile region due to the high acid content in the soil, new soil-treatment technologies have made soy cultivation possible, up until the point today, when some 62% of total soy production comes from the Cerrado (EMBRAPA, 2013). As illustrated by Freitas and Mendonça, soy has constituted an absolutely central component in the most recent wave of agricultural expansion mainly occurring in the Center-West and Northern region of Brazil, with an average annual growth of 5,06% in the area dedicated to soy production from 1994-2013, compared to 1,76% for other crops (FREITAS and MENDONÇA, 2016,

p. 506). Economic attention has been centered on the Cerrado because of its large potential for agricultural expansion. The Cerrado stretches over approximately a fourth of the Brazilian territory, and occupies some 2.116.000 km<sup>2</sup> (KLINK and MACHADO, 2005, p. 149). The marginal costs for expansion of soy production in this region are amongst the absolutely lowest in the world (ECONOMIST, 2010).

Yet, the expansion into the Cerrado region has also come to markedly affect the biosphere. The large amounts of territory needed for soy production presents some environmental problems regarding the loss of native vegetation, but also regarding biodiversity. In effect of its localization, hydrography, varying elevation and climate, the Cerrado savannah is one of the most bio diverse areas in the world (SCHLESINGER, 2008, p. 12). The region is home to half of Brazil’s bird and reptile species, roughly a third of its mammal species and around an eighth of the country’s plants species (KLINK and MACHADO, 2005, p. 149). Estimates based on satellite images made by the Brazilian Environmental Ministry suggest that by 2008, some 47% of the native Cerrado vegetation had been lost (MMA, 2010, p. 7). The rate of annual deforestation between 2002 and 2008 reached 14.000 km<sup>2</sup> (IBID). Though most of this biosphere loss has been to livestock pastures, one interviewee states that recent increases in soy cultivation also have been a major factor in this development. Studies conducted from 2002-2008 likewise indicate a high tendency of soy planting in municipalities also characterized by significant Cerrado deforestation (VITALI, 2011, p. 21).

The soy production within the Amazon presents a somewhat different course of events, as mitigation efforts have been more effective in limiting expansion within this biome. Around the turn of the millennium, the level of forest cleared in the Amazon reached preoccupying levels above 20.000 km<sup>2</sup> annually. Ferreira and Coelho associate this development with rises in food prices at that moment, – particularly with regards to soy (FERREIRA and COELHO, 2015, p. 94). In 2006, the increasing attention around deforestation of this region led Abiove (The Brazilian Vegetable Oil Industry Association) and Anec (The National Association of Cereal Exporters), representing the bulk of Brazilian soy industry, to sign a moratorium in partnership with Greenpeace, pledging not to buy soy from areas deforested in the Amazon after

2006. Public attention was also directed towards conservational efforts at this point in time. Thus, after peaking around 27.000 m<sup>2</sup> in 2005, deforestation of the Amazon fell to just below 5.000 km<sup>2</sup> in 2012 (IBID). Though deforestation rates have again risen since 2012, the soy Moratorium appears to some extent to have made it possible to decouple production increases from deforestation, and it hints at the possibility for mitigation of the negative aspects of soy expansion in cases when pressures and cross-sectorial mobilization result in an action-oriented consensus between significant stakeholders, within and around the soy sector.

The environmental recourse inputs into the Brazilian soy expansion have been an integral part of the present mode of production, which in the terminology of Hopkins and Wallerstein (1982) has come to incorporate land and entire regions within Brazil, into the axial division of labor of the world economy. This description of a horizontal labor division reflects a certain disdain amongst WSA scholars related to the presumed low value-added factor within such production processes, but also a call of attention to their potentially exploitative nature. In line with Hall's (2012) theoretical descriptions, this trend of incorporation has also been unfolding as a one-way process; increasingly consuming not only territory, at the cost of native vegetation. Yet, the signature of the Soy Moratorium and the decline of deforestation in the Amazon does somehow defy the determinism inherent in WSA perspective, and indicates that in a particular geographical and temporal context, agency by political and social agents may work to mitigate the negative impacts of commodity driven development.

## 11. Agrochemical inputs

The regions of the expanding soy frontier, such as the Center-West and the North of Brazil, are characterized by a very extensive scale of rural properties, – often between 300 and 50.000 hectares. The mode of production is mostly that of a highly industrialized monoculture, with an intensive use of technology and non-renewable recourse inputs (CAVALETTI, 2008, p. 39). Rotation of cultivations is not commonplace, which often contributes to soil degradation (NASSAR and ANTONIAZZI, 2011, p. 12). In addition to this, some farmers neglect to use techniques such as direct planting or contour plowing, which further increases the risk of both degradation and erosion of the soil. It is estimated that in the absence of these measures, for every kilo of soybeans produced, 6 to 10 kilos of soil are lost in the process (DSC, 2008, p. 24). Other estimates of the soil loss due to intensive soy production are set between 8 and 20 tons of soil per hectare every year (CAVALETTI, 2008, p. 11).

The use of agrochemicals and fertilizers is an integral part of industrialized monoculture farming like most of the Brazilian soy sector. Table 3 below illustrates how cost shares of fertilizers and agrochemicals since 2007 have been at a level between 33% and 43% of total production costs, with fertilizers amounting for the bulk.

Between 2003 and 2008, the average use of herbicides in Brazilian soy production increased from 2.8 to 4.2 kilograms pr. hectare (MEYER and CEDERBERG, 2011, p. 5). The extensive use of fertilizers and agrochemicals presents an input combination that implies the danger of a degenerative circle. The agrochemicals work by “sterilizing” the soil, destroying the naturally occurring biological organisms, and

**Table 3.** Average share of agrochemicals and fertilizers in total soy production costs from 2007.

	Agro-defensives	Fertilizers	Total share
2007	15.69%	17.80%	33.49%
2008	15.73%	25.60%	41.33%
2009	11.87%	35.60%	47.47%
2010	12.08%	23.42%	35.50%
2011	9.57%	25.29%	34.86%
2012	12,58%	30.48%	43.06%

Source: Conab(a) 2007, 2008, 2009, 2010, 2011, 2012.

thereby much of its fertility. This increases the need to use fertilizer, the basic ingredients of which - nitrogen, phosphorus and potassium – constitute a suboptimal nutrition for the plants, making them more vulnerable to insects and plagues, which again increases the need for the use of pesticides, insecticides and herbicides (BARRETO and RIBEIRO, 2006, p. 5).

One of the interviewees stresses that the introduction of transgenic soy cultivation has – contrary to the initial claim – been intertwined with an increase in the use of agrochemicals, of which Brazil has been the world's largest consumer since 2008. From the first permissions for transgenic soy cultivation were formally given in 2003, this has spread rapidly to cover nearly 90% of the area dedicated to soy production within Brazil today (SAMORA, 2012). The genetically engineered seeds are sold in a “package”, along with the herbicides necessary for its use.

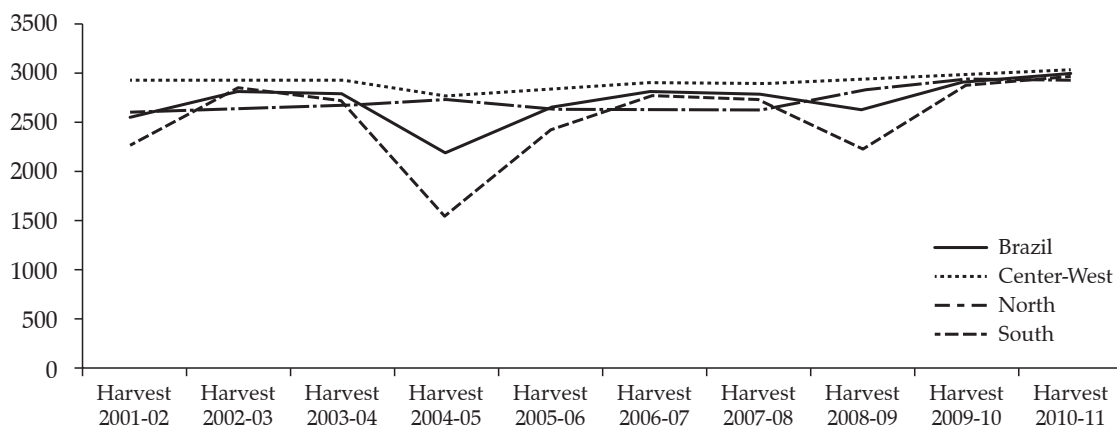
Public regulation appears to be ceding in to the pressures for expansion. From 1998 to 2004 the maximum legal value for the active ingredient in soy herbicides, Glyphosate, was increased fifty-fold along with the introduction of transgenic soy; from 0,2 to 10 parts per million (SALAZAR, 2010). Research on the soy lifecycle inputs from 2008 indicates that for every kilo of soy produced in Brazil, 139 grams of fertilizer and 3 grams of agrochemicals are needed (CAVALETT, 2008, p. 60).

The market for transgenic seeds and herbicides is characterized by a high degree of conglomeration, in which a few multinational enterprises, such as Monsanto (US), Syngenta (Switzerland) and Bayer

(Germany) are central players (SCHLESINGER, 2008, p. 7). The increasing dependence on herbicides for patented transgenic seeds, combined with the scalar expansion of soy production, has resulted in an increased flow of capital to these foreign actors in the Brazilian soy market. This has created a profit-repatriating mechanism in the very beginning of the soy commodity chain, before the actual cultivation phase, which diminishes the national share of income from this activity. Cavalett underlines how the excessive use of fertilizer and agrochemical inputs has made production profitable at the present price level, though, thereby creating a mechanism of dependence implying high production costs and environmental damage (CAVALETT, 2008, p. 83).

The high degree of dependence on agrochemical inputs in the production process constitutes very significant costs on the micro- and macroeconomic levels. Particularly farmers who depend on anticipated sales of the harvest to trading companies in exchange for production inputs face real interest rates in the range of 20%, which cut deeply into profit margins. According to a statement made in 2011 by Embrapa's Cerrado soy-sector coordinator, Sebastião Neto, while the yield per hectare from soy cultivation has surged dramatically during the last 30 years, production costs driven by agrochemical inputs have risen at the same pace, meaning that farmers in the Center-West region often need to produce more than 3 ton perha, in order to remain profitable (NETO, 2011). As can be seen on Graph 1 below, average yields per ha in soy producing regions just only reached a level of 3 tons around

**Graph 1.** Average yields per hectare in kilos of soybean for Brazil and selected soy producing macro-regions



Source: Conab(b), 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011.

2010, indicating that costs related to inputs, logistics and processing strongly press profits at the stage of cultivation.

On a national level, the increasing demand for agrochemical products, driven by agricultural expansion, has led to an accelerating trade balance deficit within the chemical sector from 2007, reaching US\$ 26,5 billion in 2011. The main component below this trade deficit was constituted by a US\$ 8,7 billion import of inorganic fertilizer intermediaries (COSTA and SILVA, 2012, p. 23).

The dependence on imported agrochemicals has come to constitute a high amount of fixed costs which both cuts significantly into the profits of the individual farmer, and constitutes a mechanism through which higher value-added activities remain at the global economic core regions. Through a WSA perspective, it may be claimed that the present reliance on an input-intensive production model serves to cement the structural differentiation in the division of labor between core and periphery.

Seen from a conventional economic perspective, the incorporation of the Brazilian frontier lands for soy production may nonetheless still be economically viable with a reasonably margin of profit, due to the present level of soy prices and structure of (non)valuation of inputs, in which land is abundant and nutrients of the soil can be freely exploited. Yet, calculations made by Cavalett, in which detrimental environmental impacts of the conventional mode of production are included, point to a negative profit margin of 14% (CAVALETT, 2008, p. 106). Ciccantell and Smiths (2009) concept of ecologically unequal exchange thereby comes to illustrate the non-valuation of depleted environmental factors, within commercial interactions between Brazil and the purchasers of its soybeans. The regulatory framework during the expansion phase has thereby generated a subsidy-structure for soy production, in which the exhaustion of natural resources becomes a necessary production input in order to ensure positive external payment balances.

## 12. Labor inputs

The modern Brazilian soy sector tends to be characterized as a very knowledge and capital intensive production. The industrialized production system

is widely mechanized and based upon the extensive use of fertilizer and herbicides, which is associated with a low need for labor power (CAVALETT, 2008, p. 1). Calculations of the average producer costs for soy production in the central Cerrado region, made first in 2007 by the Brazilian Ministry of Agriculture, concluded that of the total production costs, fixed and temporary labor expenses only reached 1.23%. In 2011, this number had risen to 1.84%. By comparison, the average share of production costs for machinery, agrochemicals and fertilizer reached 49.2% in 2007 and 54.29% in 2011 (CONAB, 2007, 2011).

At the outset of the extensive soy expansion in 2002, one employee in the Center-West region could attend to an area larger than 200 hectares, whilst in regions where family agriculture was predominant, the same worker could see to only 15 hectares or less (SCHLESINGER, 2008, p. 6). A general characteristic of modern soy farming is that the larger the area cultivated, the less labor per hectare is needed, which highlights the tendency of large-scale monoculture to generate rural exodus (DSC, 2008, p. 27). An interviewee stresses that rural unemployment and exodus have been particularly strong in the South, where small and medium scale agricultures became the first to apply Glyphosate and plant transgenic soybeans, which are associated with a very low labor need. Thus, even in spite of the rapid expansion of soy production during the past decade, the lack of potential to absorb rural labor force appears to have been a clear trend.

In spite of the low relative weight of labor inputs to production, labor conditions on soy plantations are still often very poor. An analysis of 237 governmental reports on forced labor from 2000-2003 conducted by the Brazilian journal, *Folha de São Paulo*, revealed that the use of forced labor, or labor coercion, accompanied the expansion of soy frontiers. The newspaper documented cases from the frontier regions of West Bahia and Mato Grosso, where several hundred workers at times had been released after official inspections of soy farms (LOBATO, 2004). As of 2008, the Brazilian Ministry of Labor was still investigating more than a hundred reports of slavery on soy farms (DSC, 2008, p. 26).

A 2011 report based on a research project by the International Labor Organization, conducted on a range of large scale agricultural operations in Brazil – amongst these a number of soy farms, – revealed some

very detrimental labor conditions. The report treated the notion of slavery from a broader perspective through which it comprised of deprivation of liberty, degrading working conditions, maltreatment or humiliations, and the withholding of salaries (OIT, 2011, p. 28). Deprivation of liberty became effective due to the geographical location of the farm, which made parting without assistance impossible. The withholding of salaries functioned as a tool to force indebted workers to stay, through direct threats and by the use of violence in order to retain workers (IBID, 2011, p. 33). An interviewee underlines that the extent of the use of forced labor has been very difficult to quantify, though it is mainly used in the land clearance phase. Soy production is characterized by a clear division in terms of labor, between low-skilled workers subjected to poor conditions on one hand, and technologically skilled workers with much better conditions on the other. The interviewee states that the strongest trend has been the exclusion of the large majority of rural population from participation in production.

The recent evolution of mechanized soy farming in Brazil thereby seems to have been associated with a high degree of labor exclusion in terms of the low labor inputs to soy cultivation, where labor expenses only account for a very marginal part of the input costs, which exacerbates the tendencies of rural unemployment and risk of exodus. Exploitation of low-skilled labor subjected to detrimental working conditions, a high degree of labor coercion, and low remuneration *have* been identified in many cases, but it is still difficult to evaluate its exact extent. The remuneration and labor conditions of the more technically skilled part of the rural labor force engaged in soy production also means that this group of workers should be evaluated in different light.

Proletarianization of the rural labor force, as it is drawn up by Scanlan (2012), implies the displacement of smallholders followed by a reincorporation – though in this case very limited – as cheap labor force on plantations, seems to approximate a description of the process of soy expansion in the past decade. Such labor relations are also clearly reminiscent of Hopkins and Wallenstein's (1982) periphery condition of conversion of labor. Yet, the extremely low part of total production inputs which labor constitutes, does make it difficult to affirm that any significant profit generation within the sector is derived from the exploitation of below

subsistence-remunerated labor, as Wallerstein and Hopkins otherwise point towards. Though labor conditions in some stages of soy cultivation may be poor, the most pronounced tendency related to soy expansion is that of exclusion of workers from the direct production phase. The more contemporary WSA perspectives, such as Gereau and Borrego's (2012) emphasis on tendencies of smallholder displacement by industrialized farming, rather than exploitation, thereby seem to better describe the recent developments within the Brazilian soy sector.

### 13. R&D inputs

The research and development inputs to the Brazilian soy sector have been essential for its evolution beyond the southernmost states, and are still to be considered an important part of the input structure of this commodity chain. R&D inputs to the soy production are probably most visible through the patented gene structure of transgenic soybeans, which today account for nearly 90% of soy cultivation in the country (SAMORA, 2012). An increasing part of total production costs are therefore constituted by seeds, which share of average total production costs increased from 3.85% in 2007 to 9.83% in 2012 (CONAB, 2007, 2012).

The transgenic soybeans were first introduced and patented by Monsanto. The Brazilian state-owned agriculture research institute of Embrapa was quick to launch a partnership with Monsanto, resulting in three varieties of Roundup Resistant soybeans of its own, after the definitive legalization of transgenic cultivation in 2005. Monsanto though, retained a license for the use of the seeds, which was charged for every hectare sown with RR seeds (SCHLESINGER, 2008, p. 8). Embrapa has been a central entity within Brazilian agricultural research, especially regarding the soy sector: it was in the forefront of making the Cerrado cultivable by changing soil properties through lime and phosphorous treatment, it has developed the no-tilling direct planting technique by which the soil is not plowed and thereby retains more nutrients, and through conventional breeding, Embrapa adapted soy to become a tropical crop and speeded up its growth period (ECONOMIST, 2010).

Access to recourses such as efficiency-improving inputs and application of state of the art production

methods is found by Levine and Helfand (2004) to be essential factors, which mean that particularly large-scale farms in the main soy producing Center-West region have seen a high degree of factor productivity growth. An index<sup>3</sup> of the comparative advantage of Brazilian agro-exports constructed by Souza *et al.* (2011) also positions soy as the most competitive product category, from 1996-2007, with a particularly high growth from 2000-2004 (p. 70), in part reflecting the high degree of technological gains within the sector. The high degree of investment in agricultural research within Brazil since the 1970 has also made the World Bank highlight the country's efforts in this regard as a model for other developing countries, stressing the importance of such strategically public R&D engagement (HOPEWELL, 2016, p. 548; WORLD BANK, 2008).

The main research inputs to soy production thereby rely partly on foreign patents, and partly on a range of significant national adaptations to this production system, carried out by Embrapa. This relationship is also encapsulated in the partnership agreement between Monsanto and Embrapa. The lack of structural ramifications of technology application, which is a characteristic of Hopkins and Wallerstein's (1982) concept of simple reproduction, does thereby not entirely correspond to the mode of production within the Brazilian soy sector, which is highly specialized and characterized by technological innovation. Embrapa's role in developing cutting edge environmentally sound techniques within the area, and the high degree of domestic research participation and knowledge proliferation, stands as a clear evidence of this.

Yet, in effect of its patents on the widely used RR seeds, Monsanto still represents a dominant position within the input structure of the commodity chain and benefits from a system of repatriations of a substantial share of profits. The dynamics of industrialized monoculture is better grasped by Scanlan (2012) and Gereau and Borrego (2012), who rather lead attention towards the detrimental social and environmental consequences of this production system. In similarity with the previous conclusion regarding the exclusion of labor from highly mechanized production, the older WSA perspectives' conceptualizations of periphery

conditions appear to be in need of some contemporary intermediate theorizing, in order to provide a more specific and consistent analysis of modern soy cultivation.

## 14. Crushing and processing

The crushing phase constitutes a central activity in the elaboration of soybeans after cultivation. The process of crushing results in two main products; soybean meal and raw soybean oil (CAVALETTI, 2008, p. 41). The crushing produces approximately 76% soybean meal, mainly used for livestock feed and 19% raw soybean oil, which is refined into the globally most consumed vegetable oil (NASSAR and ANTONIAZZI, 2011, p. 7). Around half of the soybean meal is exported and the rest is used mainly for poultry feeding and pig breeding (APROSOJA, 2013). The rise in soy production has constituted an essential input into the feed industry, meaning that pork production has grown between 2000-2010 from 2,55 to 3,23 million tons (ROPPA, 2014, p. 31), while poultry production surged from 5,98 to 12,31 million tons (COSTA *et al.*, 2015, p. 7).

The profit margin of soy crushing, – understood as the value added percentage of the crushed product above the raw soybean, – has been growing from 35% in 2005 to around 50% in 2009 (NASSAR and ANTONIAZZI, 2011, p.8). This underlines the increased potential for value added gains in the soy commodity chain, which this sector is capable of generating. At the initiation of production expansion in the beginning of the 2000s, the crushing sector was characterized by a rising presence of multinational companies, growing through acquisitions of smaller actors within the market (GOLDSMITH *et al.*, 2004, p. 97-98). As of 2005, the crushing sector was dominated by four foreign trading companies; Bunge, Cargill, Dreyfus and ADM, which accounted for some 59% of crushing and 61% of the exports of soybeans and its derived products (SCHLESINGER, 2008, p. 9). Bunge alone, accounted for some 28.3% of Brazilian crushing capacity, but has also become a significant player in the food processing industry and even launched different retail products based on soybean oil (ALBANO and DE SÁ, 2011, p. 63-64). Yet, the potential value added gains from crushing activities

3. In order to calculate the comparative advantage of the individual product categories, the authors apply a normalized revealed comparative advantage measure (p. 67-68).

have also resulted in political measures to subsidize this sector within many importing countries. China, which is an extremely essential export market for Brazilian soy, has obstructed the import of crushed soybeans through tariff measures and differentiated taxes, which has limited the potential for Brazilian soy crushing (NASSAR and ANTONIAZZI, 2011, p. 7). In comparison to Argentina, which stimulates crushing by subjecting raw soybeans to export taxes, Brazilian exports are largely characterized by raw soybeans, as it is illustrated in Table 4 below.

Counted as product volume, more than half of Brazilian soy exports are in its rawest form, so although this sector does imply some structural ramifications, it is still far from reaping the full potential benefits of domestic product elaboration.

The economic ramifications of activities related to the soy expansion, particularly in small and medium sized towns in the soy frontiers regions, should nonetheless be taken into consideration when making a general evaluation of the socioeconomic repercussions of this development. Although the direct production phase may be characterized by a very low degree of labor inputs, the associated agro-industrial complex in these regions does provide some amount of jobs and economic development. IBGE research from 2004 thus found that the Human Development Index (HDI) in municipalities strongly characterized by soy production was above average in 19 of 20 cases examined (AE, 2004). In their analysis of soy expansion in Sorriso in Mato Grosso, Brum *et al.* (2009) thus also find that revenues from these activities have permitted a strong increase in local public spending on health care, education, and basic sanitation, as well as a marked surge in pr. capital GDP. Cunha (2008) also identifies a strongly positive evolution of pr. capita GDP and education to be associated with soy development in Mato Grosso, but in parallel also detects a significant degree of socioeconomic inequality as part of this development.

The presence of the soy crushing sector represents a noticeable step away from the simplest reproduction of capital as this concept is presented by Hopkins and Wallerstein (1982), because this activity does generate employment and some marked structural ramifications in the food and feeding industries. Yet, as less than half of soy production passes through this link in the domestic part of the chain, a large share of value-added gains are thereby also lost. The risk of the essential economic multiplier also being transferred abroad is a fundamental problem for many raw material exporting countries. The overweight of trading companies' dominance within crushing and their control of links to the food processing industries, also indicates how the process of incorporation has become manifest through the direct acquisition of much of the production systems within this sector by foreign entities.

## 15. Output: the point of export

Exportation of the bulk of production is characteristic of the globalized cash crop farming system, of which the Brazilian soy sector has become an integral part. At this stage in the chain, multinational enterprises, and particularly Bunge and Cargill, have a strong presence through a large infrastructural and logistical network for global commercialization of soy products (ALBANO and DE SÁ 2011, p. 66). As earlier mentioned, the presence of Bunge within the soy chain, which stretches all the way from input and through processing, is also strong at the point of exports, where the company possesses a significant logistical infrastructure as well as a network of port facilities for shipping (IBID, 2011, p. 62-63).

The share of total Brazilian exports accounted for by the four largest agricultural trading companies – Bunge, Cargill, Dreyfus and ADM – reached 3.9% in 1999, but had risen to 6% in 2004; a number of which soy

**Table 4.** Exports of raw soybeans and soybean meal in million metric tons, 2011

	Raw soybeans	Soybean meal
Brazil	32	14
Argentina	10	29

Source: Nasser and Antoniazzi (2011, p. 6).

constituted a substantial part (SCHLESINGER, 2008, p. 9). In some cases, trading companies are involved in all links of the chain, from provision of credit to farmers in the form of seeds up until the purchase and export of the final product. Albano and de Sá emphasize the strong market position of the trading companies and their deep vertical presence throughout the soy chain (ALBANO and DE SÁ 2011, p. 78). The authors similarly connect this dominant position, – including the part related to international commercialization, – to the development of the international logistics structure and conditions of competition (IBID, 2011, p. 65-66).

Today, efficient supply chain management has become both an important tool for profit maximization and for achieving competitive advantage (BIZERRA *et al.*, 2010, p. 3). Therefore, control of the link between the Brazilian soy market and export destinations becomes essential for trading companies. Though the reference price for soy is determined at the Chicago Board of Trade, their extensive market power has made it possible for trading companies to obtain an oligopolistic status, by which they in practice come to determine real prices through their negotiation leverage as buyers.

On the international market, Brazilian soy products have been competing with the largest worldwide producer, the US, which has been subsidizing domestic production significantly, with total subsidies from 2000 to 2012 amounting to 27 billion (EWG, 2013). In spite of this, an increase in global demand during the 2000s has been driving prices upwards and incentivized expansion of production. Nevertheless, subsidies still function by generating counteracting downwards pressures on prices. This has resulted in a profit margin which is not sufficiently high to incorporate the negative externalities of production and the environmental degradation related to this. As of 2005, the price received for 1 ton of soybeans, of US\$ 653, generated a 31% profit, considering average production costs. Estimates of negative externalities suggest that with these accounted for in prices, the profit would have been turned into a deficit of -38% (CAVALETTI, 2008, p. 82). Current prices at around 900 USD (NASDAQ, 2015) do not leave much room for the incorporation of these externalities.

The output structure of the Brazilian soy chain reflects a governance dimension dominated by foreign

trading companies and constitutes an essential link through which the production processes have been integrated into an axial division of labor, central to the process of incorporation, described by Hopkins and Wallerstein. The downstream weight of chain governance power and external definition of prices also creates a structure of incentives, which favors expansive low-cost production and hinders the internalization of social and environmental costs, thereby exacerbating ecologically unequal exchange. It may be worthwhile to emphasize that through the WSA perspective of Hopkins and Wallerstein, such detrimental consequences related to the emergence of periphery conditions, are not “distortions of capitalist development” but rather “conditions integral to the concept”. Hence, they are thereby to be seen as natural and continually reproduced consequences of the structure of accumulation processes within the world economy (HOPKINS and WALLERSTEIN, 1982, p. 127).

## 16. Conclusion upon commodity chain analysis

The main findings upon analysis of the evolution of the Brazilian soy commodity chain from 2000-2012 are presented with indicators and findings below, leading to the theoretical interpretations according to the chosen WSA perspectives’ conceptualizations of periphery *processes*.

An evaluation of whether, and to what degree, the Brazilian soy expansion falls within Hopkins and Wallerstein’s conceptual categories of periphery conditions must necessarily take account of the complex and diversified impact of this development.

The soy boom does appear to be highly associated with the concentration of production processes, both in terms of the increase in the economic and territorial proportions of soy within the Brazilian agricultural sector. Concentration of production processes is often intrinsically associated with the product specialization of commodity-based development, and while it can be discussed whether this circumstance *per-se* can be seen as negative, it nonetheless appears to be characteristic of the Brazilian rural context in recent decades.



Table 5. Theoretical interpretations of central findings

Chain point and indicators	Findings	Theoretical interpretation
Arable land input: land access	Soy expansion resulting in unequal land distribution.	<b>Concentration of production processes</b> favoring extensive export-oriented soy monoculture above smallholders.
Arable land input: Crop displacement	Regionally varying food access problems and general uncertainties about the implications of the increasing relative weight of soy cultivation.	<b>Concentration of production processes</b> favoring extensive export-oriented soy monoculture above local diversified food production.
Environmental inputs: Soil and agrochemical inputs	In conjunction degrading soil quality which becomes a depletable production input. High reliance on agrochemical inputs which significantly cuts farmers profits and lead to trade balance deficits.	<b>Incorporation</b> of the biological realm into the world economy through exploitation of soil nutrients and patenting of genetic material. <b>Simple reproduction</b> as a substantial share of the value-added agrochemical manufacturing remains abroad, while constituting a significant component in the final price of mainly uncrushed soy exports.
Environmental inputs: deforestation and biodiversity	Extensive deforestation of the Cerrado region and loss of biodiversity, yet from 2006-2011 relatively success have been made in mitigating deforestation due to soy expansion in the Amazon.	<b>Incorporation</b> of the biological realm into the world economy through exploitation of native vegetation and biosphere.
Labor inputs: employment	Very low employment generation in the direct production phase.	<b>Conversion of labor</b> through displacement of smallholders but only a low degree of reincorporation into production.
Labor inputs: labor conditions	Indications of precarious labor conditions, though difficult to generalize.	<b>Conversion of labor</b> into the cheapest possible factor input to production.
Governance structure of the commodity chain	Strong foreign presence in the input structure, processing and international commercialization.	<b>Incorporation</b> of the productive processes into an axial division of labor in which foreign MNC's wield a high degree of market power. Direct production is nonetheless still dominated by domestic actors.
R&D inputs	Some structural ramifications from domestic agricultural research and development efforts, though still high reliance on patented seeds.	<b>Simple reproduction</b> is not the case due to the high degree of technological production inputs though <b>incorporation</b> of the genetic plant structure generates a certain degree of dependence on patented biotechnology.
Processing capacity	Some significant value added gains from crushing, feed industries, and economic development in agro-industrial hubs, though most of soy production bypasses processing at this link. High degree of external corporate control.	<b>Simple reproduction</b> due to lack of elaboration and structural ramifications, though is not the case for the smaller share of production being processed. Also some significant degree of spillover in food industries which diverge from this concept. <b>Incorporation</b> of processing into global corporate governance structures and <b>Concentration of production processes</b> on a single low value added capital-good for core food industries.

Source: Author's elaboration.

Similarly, the notion of incorporation into the global labor division also becomes descriptive of the soy expansion, both in a horizontal sense, through the dedication of increasingly large swaths of land to attend global demand, but also in a vertical sense, through the exhaustion of biological recourses due to the intensity of the mode of production. The non-valuation of such finite environmental inputs also seems to reinforce a trend, which in Ciccantell and Smith's terminology can be described as *ecologically unequal exchange*.

Conversion of labor is more difficult to clearly detect, because although the soy expansion may have displaced some agricultural activities, and many cases of detrimental working conditions do exist, the low labor-demand in the direct production phase means that the re-incorporation as salaried workforce has been very limited. If professional re-insertion happens within the agro-industrial complex, this may well be associated with a higher standard of living than smallholder farming.

The notion of simple reproduction also becomes difficult to detect as a characteristic of Brazilian soy production. The significant proportion of technological production inputs – many that are domestically developed – as well as the economic repercussions in local centers of production, or indirectly in the animal feeding industry, do appear contrary to this concept. The low degree of domestic crushing, on the other hand, is more in line with the notion of simple reproduction, and the strong foreign presence within the input and output structure of the commodity chain also means that a range of significant value-added activities bypass Brazilian actors within the soy sector.

The Brazilian soy expansion can be said to have had very diverse socio-environmental implications, and while some of its aspects do not “fit” below the conceptualizations of Hopkins and Wallerstein, other central features of this development do appear to converge with their definition of periphery processes. Though this theoretical perspective with roots in international political economy literature might help to highlight the structural character of the problems associated with the surging soy production, the foregoing analysis does also point to the need to rethink some central tenets of this line of thought in relation to contemporary issues. In this respect, it becomes particularly relevant to engage critically with the deterministic view that ascribes economic

regions to the global periphery, and presupposes the inexistence of the possibility to change this modality of global economic insertion, or to actively avoid the detrimental consequences associated with commodity production.

In relation to Brazilian soy production, this raises the question of whether this mode of production indeed is inherently detrimental, or whether some room of maneuver does exist in order to mitigate its negative impacts, while ensuring that society at large benefits from its economic dynamism. Political and social agency thus becomes central in relation to this question. While the economic structuralism presumes that political power is molded as a result of external economic impulses, instances when endogenous capacity to define national regulation in a manner which shapes development in accordance with the demands of a broader range of societal stakeholders may invalidate this presumption. The mobilization of both public, corporate and civil society entities around the Soy Moratorium constitutes an interesting case in this respect, as it hints at the possibility to defy the logic of unhindered capital accumulation presupposed by the WSA scholars.

The soy expansion thus presents a very profound trend within the restructuring of Brazilian agriculture in recent decades, which both implies a large economic significance, but also a broad range of socioeconomic and environmental challenges. While the WSA perspective may serve in order to highlight the structural dimension of these challenges, the scope of possibility to mitigate such problems will probably depend on the engagement of domestic agents. The degree of success that these actors have in shaping a political response to these questions may thus also constitute an essential indicator, in order to evaluate the usefulness of structuralist economic perspectives in examining questions related to contemporary commodity-based development.

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