Agro-terrorism? The causes and consequences of the appearance of witch's broom disease in cocoa plantations of southern Bahia, Brazil

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Published Version Information

Citation: Caldas, M. M., & Perz, S. (2013). Agro-terrorism? The causes and consequences of the appearance of witch's broom disease in cocoa plantations of southern Bahia, Brazil. Geoforum, 47, 147-157.

Digital Object Identifier (DOI): doi:10.1016/j.geoforum.2013.01.006

Publisher's Link: http://www.sciencedirect.com/science/article/pii/S0016718513000092

"Agro-terrorism? The Causes and Consequences of the Appearance of Witch's Broom Disease in Cocoa Plantations of Southern Bahia, Brazil."

1. Introduction

During the last few decades, the media, government leaders, scholars and national security analysts have all called attention to the potential threat presented by terrorism as a means for political instability (Stack et al. 2010; Govindasamy et al. 2008; Santana and Rands 2006; Cutter et al. 2003; Foxell JR 2001). Analysts typically present disturbing predictions of various threats and argue that terrorists will use weapons of mass destruction, particularly nuclear and biological, to cause widespread casualties (Cameron and Pate 2001; Carus 2002). Although biological agents have received significant attention, analyses have focused on the use of these agents to kill or injure people. Consequently, the intentional contamination of crops by biological agents has received less attention in the media and counter-terrorism efforts when compared to possible attacks on civilian populations (Monke 2004; Kohnen 2000).

In many countries, agricultural systems are one of the main economic sectors contributing to political stability. Food prices in many countries are kept low due to efficiencies in production and disease controls. Thus, the concept of "agricultural terrorism" or agro-terrorism starts to assume vital importance since a disease outbreak in an agricultural system could cost billions of dollars, reduce food supplies, drive food prices up, stop exports of valuable commodities, and thus create political instability. In this context, agro-terrorism is considered an increasingly serious ecological and economic problem of the 21st century and potentially a driver of environmental change and economic hardship worldwide (Pimentel et a. 2000; McNeely et al. 2001; RAND 2010). Questions remain to definitions of agro-terrorism. However, in a simple definition, agro-terrorism can be defined as the

intentional introduction of a plant pathogen, virus or another biological agent to kill crops or animals (Stack et al. 2010; Monke 2004; Foxell JR 2003). However, despite the importance of agricultural systems to many countries, the causes and consequences of the intentional introduction of biological agents remain understudied.

One of the challenges in agro-terrorism research -- and in bringing perpetrators to justice -- is to differentiate agro-terrorism from other explanations for disease outbreaks. Notable among alternative explanations is biocrime (or biocriminality). Biocrime also involves malevolent use of a pathogen or toxin to harm crops, livestock or people (Schutzer et al. 2005; Wheelis et al. 2002). Biocrime is thus similar to an assault crime, except that the weapon used is a pathogen or toxin. By contrast, agro-terrorism has a more specific definition; like biocrime, agro-terrorism also involves the use of biological agents to harm crops and livestock, but unlike biocrime, agro-terrorism also pursues a political agenda, as in other kinds of terrorist acts. Hence both biocrime and agro-terrorism are criminal acts via the use of biological agents, but the motives for biocrime are more varied, such as revenge or competitive advantage, and differ from those of agro-terrorism, which is eminently political. That said, it can be difficult to differentiate between the two if the perpetrators do not take responsibility and declare their political agenda. Thus, it is important to separate an agro-terrorist act with well-defined political agenda from other types of criminal acts with other motives (Wheelis 2000).

This paper is one of the first to discuss a concrete case of the appearance of a plant pathogen in an economically important region, possibly motivated by agro-terrorism. We highlight both the causes and the consequences of the intentional introduction of pathogens as a means of causing economic damage. In particular, we develop three interrelated arguments: 1) agro-terrorism and bio-crime are both intentional criminal acts of introducing

pathogens into agricultural systems to cause economic damage, but only agro-terrorism does so to advance a political agenda; 2) agro-terrorism can be difficult to distinguish from bio-crime, though there are tell-tale indicators that can point to one or the other, and 3) even if the intentional introduction of a pathogen is a political act of agro-terrorism, the consequences may or may not follow the desired script contemplated by the perpetrators, as pest outbreaks can entrain unintended economic, political and ecological consequences.

To pursue these arguments, we take up the case of the fungus *Crinipellis perniciosa* (Stahel) Singer, or Witch's Broom Disease, and its appearance in the cocoa agricultural system of Southern Bahia, Brazil. We consider possible alternative explanations for the outbreak, particularly agro-terrorism and biocriminality. We also highlight how cocoa growers, who constituted a bloc of landed elites who were harmed by the outbreak, responded to the attack by pursuing creative avenues of response as they fought to maintain their political and economic power. Finally, we evaluate the political opportunities presented by the outbreak to the leftist opponents of the cocoa elites.

This article is organized as follows. First, we review the theoretical and methodological issues at play in the study of agro-terrorism and biocrime. Second, we describe the development of the cocoa economy in southern Bahia, Brazil. We focus on the formation of the cocoa economy via the creation of a landed elite, the "cocoa colonels", and how this elite created a class of marginalized workers during boom-and-bust cycles. Third, we provide an account of the circumstances and spatial pattern of the appearance of Witch's Broom Disease (WBD) in southern Bahia, noting aspects that suggest intentional introduction to maximize the impact of the pathogen's outbreak, which nearly wiped out the region's cocoa plantations. Fourth, we discuss possible explanations for the outbreak, focusing on agro-terrorism and biocrime, and considering evidence pointing to one

explanation over the other. Fifth, we turn to the consequences of the outbreak by outlining the response strategies of the landed elite, including new labor relations, land use diversification and farm abandonment. The discussion of responses also includes an account of how farm abandonment led to land invasions (or occupations) by Social Movement Organizations (SMOs) and negotiated land buyouts, which in turn are leading to the formation of land reform settlements. We conclude the paper with a discussion of the difficulties of documenting agro-terrorism and the implications of the case of southern Bahia for the broader study of agro-terrorism and biocrime.

2. Agro-Terrorism and Biocrime: Causes and Consequences

The use of biological agents as weapons has been previously reviewed in the literature (Carus 2002), and many authors have addressed the threat of plant pathogens as weapons, and illustrated the hypothetical consequences of agro-terrorism attacks against crops (Stack et al. 2010; Fletcher 2008; Santana and Rands 2006; Hope 2004; Madden and Wheelis 2003; Wheelis et al. 2002; Meyerson and Reaser 2002; Casagrande 2002; Cameron and Jason 2001; Schaad et al. 1999; MacKenzie 1999; Rogers et al. 1999). These studies frequently argue that agriculture could be selected as a target because crops are cultivated over large areas and are poorly monitored; crops are thus vulnerable and there is relatively little chance to identify a perpetrator or the date that a biological pathogen was introduced in an area. Consequently, the disease from a biological agent may be present for months before it is identified (Ferguson et al. 2001).

These circumstances thus make it hard to establish that pathogen outbreaks are in fact intentional and political acts (Fletcher 2008). Due to the vast area that an agricultural crop may occupy it may be difficult to verify whether release of a pathogen was intentional,

because there are other sources and vectors of biological agents, which may also be present (Carus 2001; Casagrande 2000; Chyba 1998). Pathogens may be spread by biophysical processes such as wind or water, spread unintentionally by humans, via trucks traveling between infected and pathogen-free regions for example, or introduced intentionally but for motives tied to biocriminality rather than terrorism. As a result, agro-terrorism is difficult to identify because a biological agent that is introduced deliberately may be indistinguishable from one that is spread inadvertently or introduced for other motives (Stack et al. 2010; Madden and Wheelis 2003; Kohnen 2000). If the introduction is not observed; if the outbreak occurs some time after introduction, and if no one steps forward to take responsibility, it is very difficult to establish political intentionality and thus agro-terrorism (Fletcher 2008; Clunan 2008).

These issues raise questions of how to establish intentionality and a specifically political motive. Some authors have posited several possible motives for an individual or a group to intentionally target crops or livestock. In the case of biocrime, the use of biological agents may be perpetrated among competing producers seeking advantage or taking revenge, or by vandals engaged in capricious destruction of property. By contrast, key among the reasons for agro-terrorism is the desire to alter supply or demand conditions for a commodity in order to cause serious economic hardship for political adversaries (Casagrande 2000; Wheelis 2000; Horn and Breeze 1999). Motivations for agro-terrorist acts in turn contemplate a shift in the distribution of the burdens and benefits of agricultural production and political power as a result of the economic consequences of pathogen outbreaks. The presence of stark political inequalities has often been cited as one basis for disempowered groups to pursue terrorism in order to undermine the power of their opponents and thus achieve political gains (Abadie 2004). Similarly, violence becomes more likely to the extent

that control of agricultural production is highly concentrated in a few hands, marginalizing other groups. To the extent that such economic inequalities map on to the constituencies of opposing political parties, there is a basis for grievances that the subaltern party may be unable to address via legal means. And to the extent that power inequalities are extreme and institutional channels for addressing grievances are lacking, militancy may emerge, making agro-terrorism an "attractive" avenue for action.

Beyond motives by themselves is the question of the process of how pathogen outbreaks occur. This varies depending on whether or not outbreaks are intentional. Biological agents dispersed by biophysical processes like prevailing winds or along waterways or habitat corridors exhibit predictable spatial contagion patterns as they spread across landscapes. Similarly, unintentional introductions by humans often unfold via spatial contagion processes, such as along transportation corridors. By contrast, the spatial distribution of intentional pathogen outbreaks often looks very different. Agro-terrorism often targets politically important locations such as properties of highly capitalized firms (e.g., agribusiness) or political leaders. Hence intentional outbreaks are often concentrated in specific agricultural properties in a spatially discontinuous pattern. However, with time, even intentional outbreaks may then spread via biophysical or unintentional diffusion processes through the landscape. Regardless of the initial causes of an introduction of a pathogen, as the outbreak diffuses, it leads to broad mortality or morbidity of crops or livestock and thus financial losses and economic hardship. Outbreaks reduce production and income while raising the costs of containing and controlling the disease, thus reducing profitability (Madden and Wheelis 2003; Wheelis et al. 2002). In many cases, the destruction of the exposed host is often the only option, although it could bring environmental damage. The use of fungicides could be an alternative, but it would increase the costs of an outbreak since

fungicides are expensive, thus increasing production costs. Consequently, increasing production costs can reduce profitability and lead to unemployment of rural workers. Where controls may be expensive, they raise production costs; and insofar as controls may not prove effective, they reduce food production. In both cases, food shortages may result and food prices for consumers rise. Food shortages, rising food prices and unemployment can severely stress the most vulnerable groups of people. Consequently, feelings of deprivation, frustration, anger, and consequently increasing social inequalities may drive people to civil unrest and political instability.

3. The Development of the Cocoa Economy

Here we pursue an analysis of the causes and consequences of the introduction of biological agents using the case of cocoa in southern Bahia, Brazil. We review the historical development of the cocoa economy in southern Bahia in order to highlight factors that shape this region, which made it vulnerable to pest outbreaks that could cause significant economic damage. In particular, we highlight the political economy of the cocoa sector by noting how the concentration of landholdings, conservative political interests tied to cocoa, the marginalization of workers, and economic boom-bust cycles led to a highly stratified society with attendant political militancy. We suggest that these conditions made southern Bahia a likely site of agro-terrorism.

Cocoa is a native species of the tropical forests of South America, and its production has a long history in Brazil. The southern part of Bahia state in Northeastern Brazil has for long been one of the richest cocoa-producing regions in the world. Frédéric Warneaux brought cocoa seeds to the region in 1746 (Tavares 2001), and the hot, humid weather of Bahia facilitated the adaptation and growth of cocoa in the region (Figure 1).

Figure 1: ABOUT HERE

Southern Bahia was a forested region that in the 18th century only produced a few pounds of cocoa. In the 1860s, industrialization in Europe and North America increased wages and stimulated a mass market for cocoa (Wright 1992). From an annual average of 2,900 tons in the 1840s, Brazilian cocoa exports increased by 259 percent by the 1890s (Furtado 1963). This spectacular growth attracted people to southern Bahia from dry areas of northeastern Brazil to open up the Atlantic forest for cocoa plantations. Cocoa was planted in the shade of canopy trees in an agroforestry system known as *cabruca* (Rolim & Chiarello 2004). At first, migration created a cocoa system that was centered on small-scale family agriculture. However, the growth of cocoa by the end of the 19th century made it an export monoculture, which encouraged formation of large plantations that involved concentration of landownership in relatively few hands.

The development of the plantation economy in southern Bahia encouraged further migration and population growth, and the profits generated by cocoa production permitted regional development and integration of southern Bahia with the rest of the state. This expansion transformed cocoa into the main export commodity in the state, contributing more than 50% of Bahia's exports and more than 60% of the state's total revenue by the 1970s (Willumsen and Dutt 1991). As the crop became important, the Brazilian government started programs to improve land management and technology (Johns 1999). At the same time, as the crop started to achieve success, many plantation owners became absentee landowners with little interest in diversifying production or improving land management on their estates (Alger and Caldas 1994). Instead, plantation owners took advantage of

agricultural programs and used subsidized credit and fiscal incentives to diversify their personal portfolios by going into other businesses, often located outside the cocoa region (Stevens and Brandão 1961). Consequently, many cocoa farms were managed by a *gerente* (manager), with the assistance of technicians trained at local agricultural schools, with little or no supervision from the landowner (Alger and Caldas 1992). Meanwhile, absentee landlords were in the cities concentrating on marketing, getting loans from the Bank of Brazil, and sending their sons and daughters to the best schools outside of the cocoa region. Nevertheless, cocoa as a monoculture was subject to boom-and-bust cycles. Crucially, whereas booms stimulated the expansion of cocoa and thus enriched landowners, busts led to unemployment of laborers. Over time, boom-bust cycles in the cocoa sector of southern Bahia reinforced inequalities between landowners and laborers and created a class of dissatisfied and marginalized workers.

Good international prices were always the best stimulus to increase cocoa production. Consequently, the cocoa economy expanded until the 1930s when a series of economic problems in Brazil, resulting from the 1929 crash in the New York stock market, raised the first "red flag" for cocoa in southern Bahia. Up to this period, the expansion and consolidation of the cocoa economy was possible due to favorable international prices, which transformed crop production in Bahia and created a class of powerful landlords (or colonels[1]) with considerable political influence. Consequently, decreases in market prices led the Brazilian federal government to act in favor of the powerful colonels, and this marked the beginning of a phase of strong governmental intervention with the creation of the Cocoa Institute of Bahia (*Instituto do Cacau da Bahia-ICB*) that had the sole objectives of alleviating the crisis and protecting landowners in debt.

[1] Colonels were designations for powerful landowners in the northeast region of Brazil.

Cyclical crises persisted until 1957, when the cocoa sector experienced one of the most difficult moments in its history. International prices dropped to the point where it was almost impossible for cocoa farmers to cover production costs. The mounting debts of cocoa farmers caused many landowners to abandon their properties. To contain this situation, the federal government created the CEPLAC (*Comissão Executiva do Planejamento da Lavoura Cacaueira*), an executive commission that had the objective to plan the financing of the recovery of the cocoa economy. To achieve its goals, in 1962, the executive commission created the Cocoa Research Center (*CEPEC*, *Centro de Pesquisa do Cacau*). As in many other parts of Brazil, the federal government pushed for agricultural modernization (Graziano da Silva 1981), and the executive commission saw the need to modernize cocoa cultivation (Garcez and Freitas 1975). The plan of the new research center therefore focused on two points: (a) the intensive use of agricultural inputs (fertilizers, pesticides), and (b) the use of new and more productive varieties of cocoa trees (Garcez and Freitas 1975).

The development of new technologies, rebounding international prices, and abundant subsidies favored the recovery of cocoa plantations and the colonels. As a result, southern Bahia became the world's second largest cocoa producing region, after Côte d'Ivoire. For a short period of time, cocoa became the second most important export commodity in Brazil, with almost 20 percent of world production (Alger and Caldas 1994). However, this recovery had a cost. Where modernization and intensification occurred, there was also an increase in cultivated area. In fact, the area planted with cocoa increased from 274,961 ha in 1950 to 380,387 in 1970 to 562,148 ha in 1985 (IBGE 2006). Consequently, the agrarian structure evolved to become yet more concentrated, making access to land for rural workers more and more difficult (Rezende 2006). Despite its merits in transforming southern Bahia into one of the most important cocoa regions in the world, CEPLAC

became dependent on the cocoa colonels that CEPLAC supported as they expanded their landholdings (Dias 1978). Specifically, CEPLAC depended of the political power of the colonels to pressure the government for increases in the agency's budget. In turn, cocoa farmers became richer and more powerful to the point of influencing the selection of CEPLAC's main staff, while rural workers continued to suffer from low wages. Thus, state support of plantations helped to reinforce a hierarchical social structure in which the colonels and businessmen controlled the land and thereby exerted political dominance, while on rural workers were relatively powerless and exploited via low wages (Valença 1999).

But as before, prosperity was followed by another bust. Cocoa prices dropped again as a consequence of cocoa production in Africa, and the price that was negotiated at U$4,000/ton in the late 1970s went down to U$800/ton by 1986 (Menezes 1993). As expected, cocoa production in Bahia decreased (Figure 2), and to complicate matters, Brazil's economy was stagnating, with increasing inflation. As in previous production cycles, whereas cocoa booms benefitted the colonels, this cocoa bust hurt workers. The dominance by cocoa colonels, the lack of employment alternatives in a region dependent on a monoculture, and the lack of strong union movements all contributed to exploitation of rural workers. When cocoa entered another crisis period, the lack of employment alternatives forced rural workers to accept other jobs below the minimum wage and without social security in complete disregard for labor laws.

Figure 2: ABOUT HERE.

At the same time, Brazil in the 1980s underwent a process of democratization as the military government stepped aside and allowed civilian elections. This political opening

coincided with the re-emergence of leftist political parties and labor unions as well as many social movements (Toni 1999). In southern Bahia, popular dissatisfaction increased in the cocoa region, not just because of the economic crisis but also because of the widening inequalities between landowners and laborers, which prompted calls for public policies for social inclusion. As a result, various leftist parties such as the Worker's Party (PT) and Democratic Labor Party (PDT) emerged, including militant elements vigorously opposed to the conservative politics of the cocoa colonels.

In this context, as the colonels sought to manage the latest cocoa bust through intensified labor exploitation in their cocoa plantations, an unexpected event occurred. In May of 1989, the Witch's Broom pathogen appeared in southern Bahia. Previously unknown in the region, its appearance posed an additional threat to cocoa production and thus brought strong suspicion that human agency was involved in an agro-terrorist act intended to undermine the political power of the cocoa colonels.

3. Causes and Possible Motives for Witch's Broom in Southern Bahia

Witch's Broom, *Crinipellis perniciosa* (Stahel) Singer, is one of the most serious plant pathogens endemic to the Amazon region. It is a fungus well-adapted to the indigenous cocoa of the Amazon (Baker and Holiday 1957). This fungus attacks cocoa's hormonal balance, producing hypertrophy and hyperplasia followed by tissue necrosis (Holliday 1980), leading to the death of the cocoa tree. The destructive potential of Witch's Broom has long been known and studied in the Amazon, and for many years Bahia had a moratorium on the movement of cocoa in order to quarantine Witch's Broom in the Amazon (Pereira et al. 1996).

The quarantine worked until May 22 of 1989, when in a regular field visit, an agricultural technician found the fungus in the *Conjunto Santana* farm in the municipality of Uruçuca in southern Bahia. This municipality was one of the most economically important and one of the oldest cocoa producing areas in the state, with 188,986 hectares and annual production of 114,134 tons (Silva and Leite 1988).[2]

To contain the spread of the disease, CEPLAC decided to eradicate the fungus by burning the entire cocoa plantation at *Conjunto Santana*. The rationale was to minimize the damage to an important crop for Bahia and Brazil. Within three days of detection, heavy machines were used to prepare the plantation for burning. As a consequence, more than 200 hectares of cocoa were destroyed (Pereira et al. 1996). While there was widespread criticism from farmers and the population in general, the CEPLAC experts in phytopathology were optimistic about the eradication approach.

However, this confidence did not last long. A second outbreak was discovered on October 26, 1989. The second disease site was located over 100 km from the first site in another important and politically conservative cocoa producing county. This time, Camacan was the affected municipality with its 101,110 hectares of cocoa and an annual production around 50,869 tons as of 1985 (Silva and Leite 1988). In this second case, eradication was not considered a viable option anymore, and various alternative plans were discussed and tested by experts, such as chemical controls (Dorea *et al.* 1990; Setúbal *et al.* 1990).

After these two outbreaks, Witch's Broom spread from city to city along the BR-101 highway, one of the most important roads in the region (Figure 3). The disease spread and new outbreaks were detected in the municipalities of São José da Vitória, Jussari, Santa

[2] With other adjoining agro-systems, the area forms a continuous planting comprising 632,220 ha of cocoa (Pereira et al. 1996).

Luzia, Pau Brasil, and Mascote along the highway. In just a few years after the first outbreak, the fungus spread rapidly through the whole region, causing substantial damage to an economy already in crisis. In Uruçuca, where the first Witch's Broom outbreak occurred, by 1990 the area planted with cocoa fell to 24,470 ha (a drop of 75% from 1985) and production fell to 15,171 tons (a drop of 70% from 1985). The appearance of Witch's Broom in southern Bahia transformed Brazil from a cocoa exporter to a cocoa importer.

Figure 3 ABOUT HERE.

The question of how Witch's Broom came to southern Bahia became the focus of widespread speculation. Some argued that Brazil was a victim of agricultural sabotage from cocoa-producing competitor countries such as Côte d'Ivoire (Junior 2006). A second line of speculation argued that farmers with cocoa plantations in the Amazon brought the fungus spores unintentionally to southern Bahia (Pereira et al. 1996). Since many cocoa farmers had invested in other regions, this was a plausible possibility.

However, 1989 was a presidential election year. Consequently, there were many strikes, protests, and demonstrations across Brazil against the right-wing candidate, Fernando Collor de Mello, and in favor of the leftist candidate, Luis Ignacio Lula da Silva. As a result, a third explanation appeared, which was that southern Bahia had suffered a domestic agro-terrorist attack. In this version, the Witch's Broom fungus had been brought intentionally by left wing militants from the Amazon to undermine the influence of the cocoa colonels in southern Bahia (Junior 2006). Because the disease's native area in the Amazon is separated from southern Bahia by almost 2,000 km, the appearance of the pathogen reinforced the idea that human agency was involved in the disease outbreak.

The third line of speculation received considerable attention. In four interviews in 2006 to the popular Brazilian magazine, *Veja*, a technician and left-wing militant told reporters how he and five other left wing militants executed a plan called *Cruzeiro do Sul* (Southern Cross) to contaminate the cocoa plantations in southern Bahia (Junior 2006). Acting since the 1980s via protests and strikes in the region, the militant stated that the group intended to undermine the economic basis of the political power of the cocoa colonels who had influenced elections for decades in southern Bahia. In doing this, the group thought that left wing political parties would have a better chance in elections, and consequently, could promote land redistribution in the region.

To achieve its goal, the militant stated that the group brought the Witch's Broom fungus from the Amazonian state of Rondônia and selected the *Conjunto Santana* farm as their target area. The selection site to start the outbreak couldn't have been more politically significant. This cocoa plantation was owned by the president of the local Democratic Rural Union (or UDR, *União Democrática Ruralista*), a right-wing union supporting the right-wing candidate in the 1989 presidential election (Junior 2006). The area of the second Witch's Broom outbreak was similarly important in symbolic and political terms as another center of cocoa production and political control by the colonels. While a confession by a militant is not by itself proof that the Witch's Broom outbreak in southern Bahia constituted agro-terrorism, when taken alongside the spatially discontinuous pattern of the initial outbreak focused on farms of powerful colonels, one finds that both pieces of evidence point to intentional introduction of the pathogen for political purposes. However, even if one accepts the third line of explanation, it still begs questions as to whether this could be characterized as biocriminality instead of agro-terrorism. In addition, it also raises questions as to whether or not the political ends of the militants were served by the outbreak itself.

4. Consequences of Witch's Broom: Strategies of the Landed Elite

The consequences of the Witch's Broom outbreak in southern Bahia have been numerous and have transpired in a cascading fashion. Outcomes began with a decline in cocoa production, which prompted various new strategies by the colonels and opened new political opportunities for their leftist adversaries. But if it is indisputable that Witch's Broom decreased cocoa production, it is arguable whether the outbreak undermined the power of the colonels or improved the situation of farm laborers in southern Bahia.

4.1. *New Labor Relations, Product Diversification, Farm Abandonment*

For decades prior to the outbreak, CEPLAC and cocoa farmers in Bahia knew that Witch's Broom was an extremely serious threat. However, the development of resistant plants and strategies to combat an outbreak were not top priorities in southern Bahia. Consequently, the appearance and spread of the disease, the non-existence of cocoa varieties tolerant to the pathogen, and the limited effectiveness of chemical controls (Purdy and Schmidt 1996) resulted in an abrupt decrease in cocoa production. The removal of Witch's Broom and other infected parts of the cocoa tree continued to be the only management practice (Pereira et al. 1996). However, this type of practice is very labor-intensive and time-consuming, since most farmers lacked large machinery, and since it requires the careful examination of each cocoa tree, thus increasing production costs. Low cocoa prices due to the economic crisis, paired with higher production costs, lower productivity, and the lack of preparedness of cocoa farmers brought serious economic losses to the economy of southern Bahia. Trying to solve the problem, the Brazilian government opened new credit lines through the Bank of Brazil, but the crisis transformed rich farmers into farmers with huge

debts and no money to pay for the costs of fighting the disease.

After decades of booms and busts, cocoa farmers had grown accustomed to the cycles of the international market, but the appearance of Witch's Broom was a different menace and required a different response. To survive the crisis, farmers pursued a variety of strategies to manage their farms. To offset rising labor costs, some cocoa farmers in the region started to use a labor system called "*arista*[3]". In this system, the landowner allows a rural worker (and his family) to take care of a parcel of land, and this worker is responsible for all services in this area, such as weeding and harvesting. To compensate the owner, the rural worker gives a part of the production in payment for use rights. In other cases, farmers adopted the "*parceiria*" (partnership), a labor regime in which the rural worker (and his family) use the land and all tools that belong to the landowner, but compensate the landowner by giving him half of the production. Also, landowners made use of the "*contrato*" (contract), in which the rural worker assumes the responsibility for a piece of land for a period of time, usually three years, and all types of services in the farm.

In other cases, farmers moved away from cocoa and diversified their production systems to feature other commodities. Farmers logged their forested lands and cut down and burned *cabruca* vegetation in order to develop other investments (Alger and Caldas 1993). Better coffee and cattle prices in the international market provided attractive alternatives. Thus, coffee and ranching started to replace cocoa plantations in key municipalities of southern Bahia, such as Camacan (Alger and Caldas 1992). The possibility of investing in coffee production in southern Bahia also attracted the attention of traditional coffee producers of the State of Espirito Santo. Land prices in Espírito Santo were ten times higher than those in southern Bahia; the cost of one hectare of land in Espírito Santo was R$30,000

[3] The word arista comes from area. It relates to that area that a rural worker is responsible in a farm.

and in southern Bahia it was R$3,000 (http://blogdomiolobaiano.blogspot.com/2009/11/cafe-comeca-substituir-o-cacau-na.html). As a consequence, since the appearance of Witch's Broom, the area planted with coffee in southern Bahia increased 100 percent, and the number of heads of cattle increased almost 20 percent (IBGE 2006).

However, even these incentives weren't good enough for some farmers, who just abandoned their cocoa plantations due to the lack of financial resources and huge debts, in the expectation that the crisis would eventually pass. The crisis did not cease as before, and approximately 200,000 rural workers lost their jobs in the cocoa plantations by the mid-1990s (Demeter 1996). The economic downturn in southern Bahia further deepened the social marginalization of rural workers, who had no choice but to move to the cities. Consequently, the urban population of southern Bahia grew rapidly from 542,298 in 1991 to 636,670 by 2000, or 17% in nine years (Table 1). The situation of marginalized workers did not improve in the cities, because the cocoa region is not a manufacturing area that could absorb the labor force from the countryside. Despite persistent promises from the federal and state governments to find a solution to the cocoa crisis, trade and business in the major cities of the region suffered from a lack of sales, and there was substantial regional unemployment. As a result, masses of rural workers fell into social marginalization through low-wage work, unemployment, and sub-human living conditions (Simmons et al. 2007; Wolford 2005; Caldas et al. 2010).

Table 1: ABOUT HERE

4.2. *Land Occupations and Buyouts for Land Reform Settlement Formation*

The lack of support from the government and the creation of a marginalized population without jobs increased popular dissatisfaction in southern Bahia. It is well known that social movements are a significant way that ordinary people participate in political action by making claims on elites or the state (Tilly 2004). The 1989 elections occurred in the larger context of democratization in Brazil, which also prompted the emergence of many social movements across the country, including in southern Bahia. Perhaps no social movement in Brazil has been more significant than that of rural landless workers who mobilized to demand better working conditions and land reform (Branford and Rocha 2002; Simmons et al. 2010; Caldas et al. 2010; Aldrich et al. 2012). Rural landless workers' movements also mobilized in southern Bahia to contest the longstanding concentration of land and marginalization of workers there, by challenging the political power of the cocoa colonels.

While many social movements for land reform do not participate in electoral politics, it is well known that there is a significant intersection in the landless rural workers movement between leftist party officials and social movement organizations (SMOs) (Branford and Rocha 2002). This exchange of support was a key factor for landless rural worker SMOs to push a dual agenda by supporting left-wing political parties in elections, as well as direct action land occupations[4] in southern Bahia.

By undermining the economic power of the cocoa colonels, Witch's Broom provided a political opportunity for their leftist adversaries. Before the cocoa crisis, SMOs in southern Bahia were almost non-existent due to the political hegemony of the cocoa colonels. In addition, right wing politicians dominated political representation in southern Bahia. However, in 1993, four years after the Witch's Broom outbreak, one of the most important cities in southern Bahia, Itabuna, elected a congressman (*Deputado Federal*) from

[4] By Brazilian laws, individuals that occupy and improve private lands not in production for five years and a day can obtain legal right to claim the land. See Brazilian Constitution, article 191 of 1988 for more details.

the Workers Party (PT). And in the following election of 1996 for members of the city hall and mayor, all three cities in the most affected municipalities, Uruçuca, Ilhéus and Camacan, elected left-wing mayors. While this number may seem small, because those municipalities had been strongholds of the cocoa colonels, the 1996 elections were an historic reversal in southern Bahia.

In addition, land reform SMOs (e.g., The Land Struggle Movement [*Movimento de Luta pela Terra*, or *MLT*]; The Landless Workers Movement [*Movimento dos Trabalhadores Sem-Terra*, or MST], among others) began to recruit rural workers in urban centers to participate in direct action tactics (Wolford 2005, 2004). Through SMOs, the marginalized population of cocoa workers realized their own agency by making demands for land reform. Tired of waiting for concrete action from the government, rural workers instead occupied cocoa farms that had been abandoned. Together, urban recruitment and rural land occupations constitute a process known as Direct Action Land Reform, or DALR (Simmons et al. 2007). The lack of jobs, poor land management, and the abandonment of cocoa farms became a unifying rallying cry for landless workers pursuing DALR occupations in southern Bahia.

In northeastern Brazil, settlements formed by DALR occupations represent 45% of all such settlements in the country (INCRA 2011). This high percentage is a consequence of contentious land occupation in a region characterized by historical land concentration, but it is important to note two points that make southern Bahia somewhat different from the rest of Brazil. First, violence was not a big problem like in the Amazon from the 1980s to the early 1990s (Schmink and Wood, 1992; Hall, 1987; Almeida 1995; Aldrich et al. 2012) since only a few murders over land occurred during the same period of time. Second, parties in agrarian conflict in southern Bahia pursued land buyouts as a means of resolving their differences.

This second point deserves further comment, because farmers were willing to be bought out for two main reasons. For one thing, the crisis had burdened farmers with debts, so they were not prepared to assume the costs required to combat Witch's Broom. In addition, many landowners were living in the cities. This permitted close ties between colonels and staff of the Bank of Brazil (Alger 2003), an institution that provides direct loans and credit for agriculture. This connection facilitated foreclosures on loans wherein the Bank of Brazil took the property as well as its attendant debts (Região 1998). In this context, the Bank of Brazil viewed such transactions as attractive since land was a fungible asset unlikely to lose its value.

Given their debts and contacts with the Bank of Brazil, some landowners adopted the unprecedented tactic of actually inviting landless groups to occupy abandoned cocoa plantations. Further, these property owners agreed not to contest occupations[5] in court. The objective for landowners was to secure commitments from INCRA (the National Institute of Colonization and Agrarian Reform) for fast compensation at a fixed price negotiated with the Bank of Brazil. INCRA would act as the negotiator between the landowner, landless people and the Bank of Brazil. Due to low land prices in the region, this tactic seemed to be a win-win situation since the Bank of Brazil closed out debts on better terms than through farm repossession (Alger 2003). Indeed, the politics of occupations and buyouts prompted some landowners to try to sell their land to landless people for a price higher than the market price. INCRA is anxious to seek commitments of non-confrontation and non-violence from occupants to avoid attracting negative attention from human rights organizations and result in criticism over evictions, so landowners would demand a higher

[5] A crucial distinction between occupation and invasion exists. In the discourse of the landless militants, they occupy land that is not in fulfillment of a social function. However, for landowners, the landless movement is invading their properties (Caldas 2008; Simmons et al. 2010).

price for agreeing to negotiate buyouts (Alger and Caldas 1993; Caldas 2008; Simmons et al 2010).

As a result, the cocoa crisis in southern Bahia led to a proliferation of land reform settlements. Before the economic crisis, southern Bahia had only seven land reform settlements linked to four social movement organizations. The cocoa crisis of the 1980s stimulated 64 new encampments involving 4,538 families, and by the beginning of 1990s, settlements were linked to 37 different social movement organizations (INCRA 2011). Furthermore, since the appearance of Witch's Broom around 1990, 35 additional settlements were created in an area of 25,043 hectares with almost 1,500 families (Table 2).

Table 2: ABOUT HERE

5. Discussion and conclusion

In contrast to earlier cocoa crises, the crisis of the 1980s led to an unprecedented situation for cocoa producers in southern Bahia. The combination of low commodity prices, Witch's Broom, and rising labor costs meant that waiting for cocoa prices to rise would not be a sufficient response. The new conditions of the crisis therefore yielded several important consequences. First, the political power of the colonels was undermined, with the decline of their economic power. Second, the crisis created opportunities for social mobilization by political leftists who pursued both successful electoral campaigns and direct action tactics via land reform settlements. And third, landowners responded in new and creative ways, whether via new labor regimes, different economic activities, or acceptance of occupations and via buyouts.

While those dynamics are clear, it is less clear how best to characterize the processes behind the Witch's Broom outbreak in southern Bahia the first place. The appearance of

Witches' Broom in southern Bahia in 1989 has been described by *Veja* magazine as an agro-terrorist act due to the fact that it was politically-motivated, with two important goals. The first goal was to disrupt the political power of the cocoa farmers, and second, to promote socio-economic changes through elections and land redistribution in southern Bahia (Trevizan 1996). Assuming that the motives attributed by the magazine are correct, it seems that the first goal was achieved with the decline of the cocoa economy and the subsequent erosion of the political power of the right wing bourgeoisie. In other words, the appearance of the disease undermined the political power of the traditional oligarchic elite by decreasing its socio-economic status as evident in election losses and land occupations.

However, the only claim of responsibility was based on a single interview. For some, such a confession could be considered evidence of an act of agro-terrorism (Casagrande 2000). The spatial targeting of the initial outbreaks on the farms of politically influential colonels supports this interpretation. However, the confession stimulated debate and doubts as to its veracity, as well as whether or not the outbreak was politically-motivated agro-terrorism or merely biocrime as revenge-taking (http://bahiadefato.blogspot.com/2006/07/cientistas-desmascaram-revista-veja-no.html; http://introtoglobalstudies.com/2012/03/witches-broom-the-mystery-of-chocolate-and-bioterrorism-in-brazil/). Thus, while there are indications that Witches' Broom was intentionally introduced into southern Bahia, the characterization of this as an agro-terrorist attack is not entirely ironclad.

The other issue that remains less than entirely clear concerns the reported second goal of the militants concerning land redistribution in southern Bahia. Even with land occupations and buyouts, available data cast doubt on the proposition that there has been a fundamental modification to the concentrated agrarian structure in southern Bahia. For

instance, rural properties with fewer than 10 hectares still correspond to only 1.9% of the total area for rural properties; at the other extreme, medium properties (80<300 ha in size) and large properties (over 300 hectares) still hold 64.8% to the total area of rural properties in southern Bahia (IBGE 2006). This does not mean that land expropriation is not occurring. In fact, 95% of settlement formation is occurring in large properties. Nonetheless, despite expropriations, large landholdings still hold most land in southern Bahia; for militants, this is still not a desired land distribution.

One might argue that Witches' Broom stimulated the onset of land occupations, which will continue to erode the longstanding agrarian structure. However, there are reasons to doubt that more time is all that is required for fundamental change to occur. For while some farmers have indeed abandoned their farms or cooperated in having their farms occupied and bought out, many others have instead engaged in new labor relations or pursued production of other commodities. This implies that the eventual adjustment in southern Bahia's agrarian structure will be limited to those farms that are abandoned, and given the presence of alternatives for landowners, it remains to be seen whether or not occupations will ever come to comprise a large portion of land in the region.

Potentially lost amidst the debate over the Witch's Broom outbreak and its political consequences are the equally important environmental ramifications. It is important to observe that both the economic crisis and Witch's Broom could be bringing serious consequences to the Atlantic Forest, most of which has already been lost in Brazil (Chomitz et al. 2006; Saatchi et al. 2001). The cocoa region of southern Bahia is one of the richest centers of endemism in the Atlantic Rain Forest (Thomas et al. 1998) and an important biodiversity "hotspot" (Brown 1975; Fonseca 1985; Mittermeier et al. 1982; Myers et al. 2000). While the expansion of cocoa in southern Bahia is by no means entirely benign, at

least it involved the *cabruca* agroforestry system that retained forest canopy. The economic alternatives to cocoa – logging, ranching, and intensive coffee – present more severe ecological threats. Thus, the decline of the cocoa economy is likely to threaten natural forest fragments, since the lack of alternatives could stimulate farmers to clear more forest (Alger 2003; Saatchi, et al. 2001).

The case of Witch's Broom in southern Bahia begs larger questions about the study of agro-terrorism. Southern Bahia is not different from what we see in much of the developing world, especially Latin America: there is unequal access to land, limited non-agricultural employment opportunities, and other social issues that contribute to persistent poverty, resulting in a large marginalized population. Further, southern Bahia has experienced repeated commodity boom-bust cycles where booms concentrate economic power, which is parlayed into political dominance, and busts historically squeezed farm laborers, increasingly marginalizing them over time. The concentration of wealth and political power is a legacy of the colonialism in Brazil, and Latin America in general. Under such conditions, marginalized groups may pursue their objectives outside normal institutional channels such as social movements and political contention (Tilly 1978).

It is therefore worth commenting on the relationship of social movements and the potential for agro-terrorism. Whereas social movements have arisen throughout Latin America to give voice to grievances stemming from social inequalities, it is far from clear that mobilization necessarily or usually involves violence along the lines of agro-terrorism. Although the concept of agro-terrorism emphasizes the use of biological agents to kill animals or crops (Tucker 1999, 2000), rural landless SMOs in Brazil have pursued land occupations and not used biological agents. This is not to say that violence has not occurred or that radicalism is not evident in agrarian reform movements. Some land invasions have

been accompanied by destruction of farms and intense political conflict involving violence between rural landless people and landowners (Folha de São Paulo 2012; Aldrich et al 2011; Simmons et al. 2010; Hidalgo and Richardson 2007). In addition, rural landless SMOs have articulated a movement strategy explicitly targeting agribusiness (Liberation 2012; Welsh 2004). For instance, a manifesto called "Carta de Ribeirão Preto" from the powerful agribusiness association of São Paulo stated that the Movement of Landless People (MST) is creating an insecure and unstable environment through its criminal invasions and vandalism of private property (Folha de São Paulo 2012; Welch 2004). In the same year, the MST destroyed eucalyptus plantations of a Canadian-owned company in Brazil, attracting severe criticism from the landed elite (Welch 2004). While some accusations have greater supporting evidence than others, they do suggest that SMOs are pursuing contentious tactics other than agro-terrorism; vandalism is after all a form of biocrime.

But insofar as such tactics are pursued as part of a political agenda, they approach the conceptual border between biocriminality and agro-terrorism. This in turn begs the question of where the tipping point between the two resides, and more fundamentally, what conditions push social movements to employ biological agents to kill crops and animals. It is useful to consider the conditions necessary for political tactics to change, as from land invasions to agro-terrorism. The case of southern Bahia is instructive in this regard. Beyond a concentrated agrarian structure and dominated polity, requirements may include 1) reliance on a well-established monoculture, 2) known vulnerability of the monoculture to a disease pathogen, due to a lack of cultivar varieties and/or to a large number of pathogens, 3) political militancy and organizations with the capacity to carry out agro-terrorist attacks, and 4) a sympathetic population that stands to benefit from the upshot of such attacks as via alternative political leadership associated with agricultural systems that promise broader

economic opportunities for marginalized groups. Here the broader literature on terrorism is useful in highlighting elements such as these (Seebeck 2007; Carus 2002; Cameron and Jason 2001; Foxwell JR., 2001; Wheelis et al. 2002; Wheelis 2000).

Finally, the case of Witch's Broom in southern Bahia serves as a useful point of departure to consider the fallout from an agro-terrorist attack or biocriminality. Some of the ensuing history of southern Bahia followed the hopes of leftist political parties and their SMO allies, as via the reduced economic power of the colonels, but other aspects did not, as via the persistence of land concentration. Southern Bahia is especially instructive as a conservative region where cocoa farmers nonetheless adopted unprecedented measures such as new labor relations, new land uses and even accepting land buyouts in response to their rapidly changing economic and political circumstances. Hence in some sense the use of biological agents for criminal or political ends can be a game-changer in that it may modify long-standing responses to economic crises. That said, the outcomes of attacks with biological agents are not readily predictable nor necessarily to the benefit of the perpetrators or subaltern groups. More attention thus needs to go to the upshot of agro-terrorist attacks and biocrime as to whether or not those responsible and/or those who stand to benefit in fact are able to realize economic or political gains.

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