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Shaping Brazil's emerging GMO policy: opportunities for leadership

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• *Genetically modified organisms (GMOs), when first developed, were seen as bringing hope to developing nations. In Brazil, as elsewhere in the world, many believe that the consumption of GMOs in foodstuffs, commonly referred to as 'Franken foods', is harmful to one's health and the environment. Yet Brazil has much to lose and much to gain. For Brazil, the GMO debate centres around growing, developing and exporting soybeans, the country's hottest cash crop. The prominence of agribusiness in Brazil's economy, its abundant farm land, and developing road and seaport systems, coupled with sweeping changes to GMO policy, both domestically and among trading partners, puts Brazil in a unique leadership position. Much is at stake as the impacts of GMOs, mandatory labelling and environmental stewardship are debated. Balancing these competing interests will have a significant impact on Brazil's future as the world's second largest producer of soybeans.*

Introduction

Genetically modified organisms (GMOs) ushered in what has been called the 'gene revolution'—a way to improve agricultural productivity and alleviate hunger for millions of people in developing nations. Increasingly, the debate over GMOs has created an ideological divide between people and nations over the benefits and risks of genetically modified (GM) food. Advocates of GMOs, mostly in the USA, Argentina and Canada, believe that these products reduce pesticide use, increase crop yields, improve the efficiency of fertilizer and reduce damage to the environment. GMO crops, advocates argue, will feed larger amounts of people while being cultivated on less land. But opponents see the GMO issue very differently. Many in Brazil, the EU and other developing nations fear that the consumption of GM food is harmful to human health and the environment, and ultimately will damage the global food supply.

Why Brazil?

Why is Brazil uniquely positioned to lead in the worldwide policy discussions on GMOs? Brazil can lead in creating policy mechanisms to generate economic development, promote technological innovation and preserve the

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ecologically diverse Amazon Basin. Brazil possesses sufficient land and labour to meet the increasing worldwide demand for soybeans, and is already one of the largest soybean-producing nations in the world. Moreover, its soybean production is mounting at an increasing rate. The economic future of Brazil is heavily dependent on its successful production, exportation and commercialization of soybean products. When combined with Brazil's developing infrastructure of roads and seaport systems, and ability to label, trace and create accountability mechanisms from farm gate to grocery store, soy can be grown and exported to global markets in an efficient, perhaps eco-friendly, and effective manner. In meeting demands from many constituencies, Brazil can exceed expectations and gain an advantage in creating sustainable soybean and GMO policies.

Brazil, the fifth largest country in the world with the twelfth largest economy in the world, is driven in large part by its agricultural exports—especially soybean exports. In recent years, Brazil has worked to position itself more prominently in regional and world agriculture politics through a leadership role at the UN and MERCOSUR, the Latin American trade bloc with Argentina, Uruguay and Paraguay. Brazil currently faces the delicate task of balancing te environmental and regulatory demands of GMOs to ensure labelling and safety of its agricultural products. This balancing act, if it is not satisfactorily resolved, could have a widespread ripple effect on the country's economic, political and social future.

At the heart of Brazil's GMO debate is the increasing world appetite for the soybean. World soybean consumption has grown over the past ten years at a rate of 5.4% versus an average annual rate of 4.8% since 1970 (Flaskerud, 2003). The Chinese and EU appetite for soy products have fuelled Brazil's increasing production. Brazil, one of the largest trading partners with China, currently exports 25% of its soybean harvest to the Asian nation (Rohter, 2003; Verdonk, 2003a). Brazil shipped 6.1 million tons of soybeans, worth \$1.3 billion, to China in 2004 (*Reuters*, 2004a). Brazil also maintains a close relationship with the EU, which is Brazil's largest overall export market. Brazil's leading trade partners for soybean products in the EU include the Netherlands, Germany, Spain, Portugal, France and Belgium. The low cost of land, rising price of soybeans and increasing worldwide consumption encouraged farmers to smuggle Monsanto's Roundup Ready GM soybeans across the border from Argentina. These actions precipitated Brazil's 'transgenic crisis'.

Brazil's abundant natural resources, coupled with increasing international consumption of soybean products, have created a land rush (Shean, 2004). Brazil's wet and humid climate presents an ideal growing season—September to March—for the soybean plant. With these favourable conditions, Brazilian soybean exports grew from 24.15 million tons in 1995 to over 51 million tons in the 2002-2003 growing season (*Soystats*, 2003). **Figure 1** shows that soybean production is evenly divided between the southern and centre-west regions (Flaskerud, 2003; Astor, 2003). The production and yield of soybeans is growing fastest in the state of Mato Grosso, where harvests are expected to increase to 100 million tons by 2007, almost five times its current level and equal to Brazil's total soybean harvest in 2002 (Flaskerud, 2003; Astor, 2003).

Understanding the current opportunities for Brazil's leadership among GMO policies requires an examination of the current public policy demands of growing, exporting and distributing GMOs. Some of the most stringent policies regarding GMOs have been passed by the EU, a significant trading partner of Brazil. Other worldwide regulations affecting GMO production or exportation, such as The United Nations Cartagena Protocol and the World Trade Organization (WTO), are also examined. The EU, US, UN and WTO policies on GMOs are examined in the next sections.

Brazil's trading partners: EU and US regulatory framework on GMOs

The EU has developed significant policies regarding biotechnology over the past

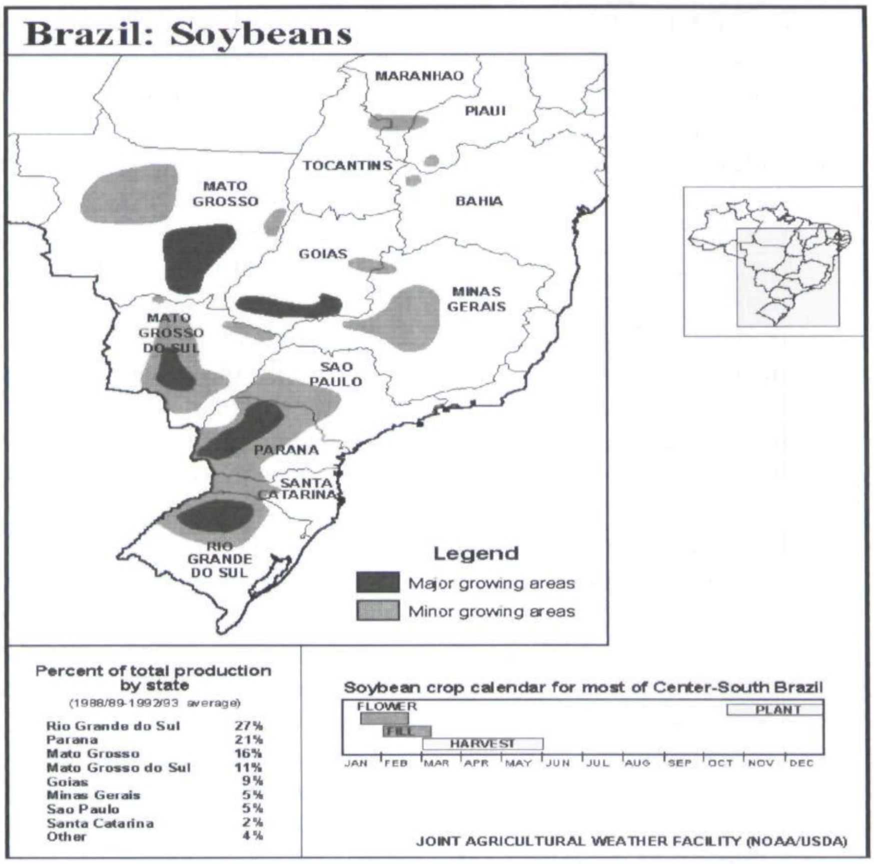

Figure 1. Soybean production in Brazil.
Source: http://www.usda.gov/agency/oce/waob/jawf/profiles/html/brz/brzsoy.html

decade. Focusing on foodstuffs for human consumption, the EU is creating a comprehensive regulatory framework to guarantee that all GMO products are safe for human and animal health, as well as the natural environment. Early regulations concerning GMOs in the EU went into effect in October 1991. More recently, Directive 2001/18/EC has created a step-by-step approval process on a case-by-case assessment. Human health risks and environment impact are carefully monitored while strengthening older rules concerned with public disclosure, monitoring, labelling and traceability, testing and European Parliament authorization on future decisions.

Two new EU regulations (1829/2003 and 1830/2003) became effective on 18 April 2004. These regulations strengthen the traceability and labelling of GMOs as foodstuffs and feed products. Although labelling has been mandatory since 1997, these new rules create a uniform system to trace GMO products, introduce the labelling of GMO feed, reinforce the current labelling rules and establish a streamlined authorization system for GMO release into the environment.

The USA, another trading partner of Brazil and number one producer of soybeans in the world, regulates GMOs through existing regulations. In contrast to EU policy, the USA does not treat GMOs as a wholly separate category for agriculture or food regulations. The US Food and Drug Administration (FDA), the primary regulator of all food in the USA, drafted voluntary guidelines for GMO foods in 2001. These guidelines assist manufacturers wishing *voluntarily* to label their foods. The FDA recognizes several acceptable statements, including '*genetically engineered*', '...*developed using biotechnology*' or '...*developed through biotechnology*' (US Food and Drug Administration, 2001).

Worldwide regulation: UN Cartagena Protocol and the WTO

The UN Cartagena Protocol on Biosafety was adopted in January 2000. The Cartagena Protocol strives to create common rules for regional and international movements of GMO products, to protect the natural environment (long-term biodiversity) and human health. After 50 member states of the UN, including all members of the EU, ratified it, the Cartagena Protocol went into effect on 11 September 2003. Signatory nations use the 'advanced informed agreement' procedure for importing or exporting GMO products. This procedure establishes safety measures for the environment and human health while addressing potential risks posed by GMOs. Countries that signed the Protocol are expected to regulate, manage and control the risks associated with the use and release of GMOs. Any shipment of GMOs has documents stating that the GMOs are in conformity with the Protocol. Shipments of GMOs for feed or direct use must be identified as 'may contain' GMOs.

A collection of countries, commonly known as 'the Miami Group', comprising Argentina, Australia, Canada, Chile, the USA and Uruguay, worked to prevent ratification of the Cartagena Protocol in 1999. These countries championed the principle of sound scientific knowledge put forward by the WTO. The Miami Group stresses that the Cartagena Protocol violates WTO agreements. Proponents of the Cartagena Protocol, however, value safeguards and the 'right of refusal' regarding imports of GM products, especially in cases where scientific proof of environmental impacts is lacking.

The WTO, while not specifically addressing GMOs, has several sections dealing with importing GMO products. Two critical sections are the Agreements on the Application of Sanitary and Phytosanitary Measures (SPS) and the Technical Barriers to Trade (TBT). Both the SPS and TBT require signatory nations not to comply with measures that make the trade of items more restrictive. The TBT section specifically states that member states are not allowed to give less favourable treatment to any product. These measures have led the USA and other GMO-producing nations to initiate dispute proceedings against the EU's *de facto* moratorium on the approval of new GMO products (Baumuller, 2003). If they are successful, Brazil may not be able to gain significant advantage. By adopting a comprehensive GMO policy including tracking/ separating the commodity, Brazil can respond to the EU and other countries that have signed, and abide by the Cartagena Protocol requirements.

While worldwide policies are extremely important for exporting Brazil's hottest cash crop, the soybean, Brazil has already developed numerous innovations for regulatory oversight of GMO seeds and transportation policies. Brazil's current regulatory oversight is examined in the next section.

Brazil's current GMO regulatory framework

Lessons learned from ten years of regulatory, political and legal challenges with GMOs have been hard won in Brazil. Brazil's first law regulating GMOs in 1995 consolidated various departments and agencies that handled GMO certification, testing and oversight to create the Brazilian National Technical Committee on Biotechnology (CTNbio). A few months later, Presidential Decree 1752 provided the legal and regulatory framework under which the CTNbio operates (Silva, 2003a). The CTNbio was given the authority to develop regulations to deal with all aspects of GMO biosafety, from seeds in the laboratory to the commercialization of GMO products. CTNbio also provides the technical opinion on the environmental and food safety aspects of GM plants to other governmental agencies such as the Ministries of Health, Agriculture and Environment (Possas, 2002). After a GMO product enters the food chain, it is regulated by ANVISA and the National Ministry of Health.

In 1998, CTNbio approved Monsanto's Roundup Ready soybean for commercialization on a five-year monitoring plan. Following approval of the Roundup Ready soybean, CTNbio faced legal battles from national and international environmental organizations trying to stop the planting of GMO crops in Brazil. The ensuing legal action, lasting over three years, led to a moratorium of planting GMO crops. In July 2001, CTNbio was granted clear authority over the GMO testing process, with a mandated 4% tolerance limit on foods containing GMOs. The election of Brazilian President Da Silva in January 2003 saw a more concerted effort by the government to deal with the GMO issue. Da Silva, who initially opposed GMO crops, signed Executive Order 4602 soon after his election, to create a nine-member interministerial working group to develop recommendations for comprehensive GMO rules (Silva, 2003a). Shortly afterwards, the Brazilian Congress took up debate on legalizing GMO crops. Farmers were granted amnesty for planting illegal GMO soybeans, and new rules were proposed to control the country's black market in GMO soy. The Brazilian Congress passed Provisional Measure 113 on 26 March 2003, recognizing the planting of GM soybeans in Brazil. The Brazilian Government, following the passage of Provisional Measure 113, set out to create a nationwide framework to regulate GMOs. President Da Silva would later sign Executive Order 4680, on 24 April 2003, lowering the mandatory limit to 1% tolerance for food or food ingredients containing GMOs.

While a new, national regulatory framework was being created, Brazilian farmers were planting GM soybeans in record numbers. Within his own cabinet, President Da Silva faced opposition to GMO testing and commercialization. The president, expressing the intense pressure faced by Brazil, stated:

> *There were two options: either we prohibit GMO soy and ordered the police to set fire to it which would have been a terrible picture in a country suffering from hunger, or we could create a situation allowing its sale* (Golbitz, 2003).

With GMO soybeans increasing in yield by over 20 bushels per acre, increased crop yields led to healthy profit margins, estimated at 15–30%, for individual farmers (Smith, 2003; Shean, 2004).

In September of 2003, Provisional Measure 131 legalized the planting of GMO soybeans for the upcoming planting season (Silva, 2003b). All farmers had to register and sign a declaration acknowledging the planting of GMO soybeans. In the southern state of Rio Grande Do Sul, the Government received over 40,000 signatures (*Dow Jones*, 2003a). Currently, estimates suggest that 10–20% of Brazil's soybean crop is GM, with 80% of the soybeans planted in the state of Rio Grande do Sul being GM (Verdonk, 2003a; *ODJ Commodity Wire*, 2004a).

Yet dissent in different states remains. The Parana State Governor Roberto Requiao signed a law prohibiting the shipment of GM soybeans shortly after the federal law approved the planting of GM crops in September 2003. The ban in Parana and subsequent strike at the port of Paranaguá has cost Brazil over $280 million dollars in lost revenue from October 2003 to January 2004. (Riverasm, 2004). Brazil's Federal Supreme Court suspended the Paraná state ban but the state has not complied with the court order. The strike left a line of more than 4000 soybean trucks, stretching over 80 kilometres long. The bottleneck saw the commodity price of soybeans rise, but many foreign customers began to question Brazil's reliability as a soybean supplier (Lewis, 2004). This strike illustrates the importance of creating an integrated, comprehensive GMO policy addressing environmental, agricultural and health concerns. This situation remains at a standstill, and the port remains closed to GM products in violation of the new Federal Law.

Opportunities for leadership

Brazil's sheer size, agriculture base, increasing rate of soybean production, infrastructure development and desire for comprehensive GMO policies can significantly influence domestic, regional and international GMO policies. Systematically integrating disparate policies can effectively guide farmers in planting seed and transporting crops to markets around the world while assisting researchers in examining the longer term impacts on health and safety of GM products. Three specific areas for Brazil's leadership as a thought leader are highlighted below:

- Growing crops with viable seed while encouraging biodiversity of the land;
- Transporting crops to market by developing effective infrastructure and seaport policies;
- Developing appropriate testing, labelling and regulatory oversight to meet the public expectations for safety and health impacts.

Each of these three opportunities for leadership is highlighted in the next section, with specific recommendations for Brazil's developing GMO policies.

Growing GMO crops

Recent estimates suggest that soybean production will increase 500% and jeopardize 25 million acres of Amazon rainforest (Flaskerud, 2003). Brazilian President Da Silva, who supports increasing soybean cultivation, has said that: '. . . *the Amazon is not untouchable*' (Rohter, 2003). The growth of soybean production, with its requisite deforestation of the Amazon area, threatens Brazil's major source of fresh water, the Amazon River. Deforestation of the Amazon is estimated to be occurring at a rate of nearly 2 million hectares per year, largely due to the demands of agriculture (Shean, 2004).

Encouraging settlement of new soybean farmers on abandoned or cerrado lands, Brazil can preserve ecologically sensitive areas in the

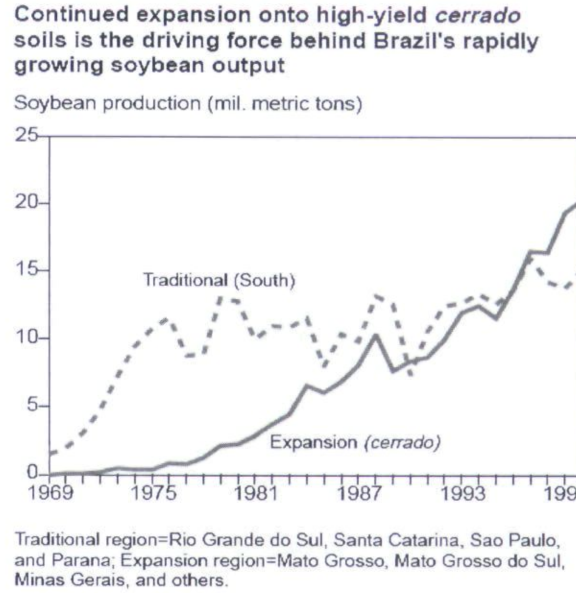

Figure 2. Cerrado land and soybean production. *Source:* USDA; July 2001.

Amazon rainforest (see **Figure 2**). Currently, 30% of all soybean acreage is being cultivated in the Amazon region, representing 4.9 million hectares (Shean, 2004). Loans, investment credit and/or price supports from the Central Government of Brazil, the National Food Supply Company (CONAB), the loans of the Federal Government Programe (Empréstimo do Governo Federal Sem Opção de Venda-EGF/SOV), the World Bank or Inter-American Development Bank could help to offset the cost of encouraging settlement on cerrado land. Combining incentives and Government programmes can help to relocate existing farmers and encourage new farmers to plant soybeans in other areas. The state of Mato Grosso alone has over 12 million acres of abandoned land that could be used for soybean cultivation (Astor, 2003).

To balance deforestation trends associated with soybean production, Brazil can continue its long history of partnering with the World Bank. The Bank presently finances 53 projects, with commitments totalling $5 billion ranging from education, agriculture and water sanitation, to transportation. By building on its rich tradition of partnerships with non-governmental organizations (NGOs), such as the World

Bank, Brazil can create a comprehensive policy with other NGOs, such as the Rain Forest Trust and principals of the Amazon Region Protected Areas Program (ARPA). Streamlining contact points under the auspices of the World Bank's Amazon Working Group (GTA), a quasi-governmental institution, can promote nature conservation and sustainable development, and reduce duplication of efforts. Using the Amazon Working Group as a central clearing-house can reduce bureaucracy, ensure impartial oversight of the funds provided and eliminate inter-ministerial redundancies related to conservation and GM soybean regulations.

Growing GM crops presupposes the existence of viable GM seed. Brazil is well positioned to continue its field tests of GM seeds. The CTNbio is currently conducting more than:

> *...1000 contained field tests with transgenic plants, including corn, soybean, cotton, eucalyptus, sugarcane, tobacco, potatoes, sweet corn and papaya. The majority of these tests have been to create products that are resistant to insects, viruses and herbicides* (Portugal *et al.*, 2004).

EMBRAPA, Brazil's crop research agency, has recently been working on creating a GM soybean similar to Monsanto's Roundup Ready seed (Ewing, 2004).

EMBRAPA has started experimental open-air planting of GM crops, and recently launched a study of the impact of GM organisms on soil and other microorganisms (*Latin America News Digest*, 2004). Additional partnerships with Monsanto, Bayer Cropsciences or Archer Daniels Midland could help to develop other GM seed varieties that could reduce pesticide use or increase crop yield.

Additional partnerships with local biotechnology firms can create improvements in crop yields. Combating problems of leaf rust can increase productivity—as demonstrated with the Codetec partnership. Brazil's climate is warm, rainy and humid, which serves to spreads the devastating Asian soybean rust. Leaf rust prevents the soybean from filling out normally. In 2002, 10% of the acreage of soybeans in the Brazilian states of Parana, Rio Grande do Sul, Mato Grosso, Mato Grosso do Sul, Sao Paulo and Goias were contaminated by leaf rust (Verdonk, 2003a). By 2003, estimates suggest that the fungus reduced harvesting by as much as 30% in the states of Mato Grosso and Bahia (Verdonk, 2003b). No rust-resistant seed varieties are currently available to Brazilian farmers. Preventing leaf rust through repeated pesticide applications is very expensive, at $50 per hectare. The success of the Codetec partnership can help to mitigate leaf rust and increase soybean crop yields while improving farmers' acceptance and understanding of GM products.

Transporting crops to market

The ban of GM soy at the port of Paraná in October 2003 and subsequent strike in March 2004 highlighted the need to improve the port's transportation infrastructure. The Paranaguá situation emphasized the need for infrastructure investment to keep up with growth of soybean exports (*Dow Jones*, 2003b). Brazil has partnered with the World Bank and Inter-American Development Bank on several important infrastructure projects, including the Goiás State Highway Management Project, Rio Grande Do Sul State Highway Management Project, Highway Corridor Integration Program for the State of Bahia and the Federal Highway Rehabilitation and Decentralization Project. Encouraging private investment to improve the country's infrastructure and spur sustainable economic development is an important near-term strategy. Some private sector infrastructure projects include construction of the Brazilian port of Santarém, and Cargill's (Brazil's largest soybean exporter) port terminal at Santarém on the Amazon River. Other private sector infrastructure projects include paving parts of Highway BR-163 (Diaz, 2004a), linking the capital of Mato Grosso, Cuiabá, to the Amazon River port of Santarém. A total of 1006 kilometres of paved roads and more than 80 bridges need to be built or reconstructed to complete Highway BR-163 (Verdonk, 2003b). More than 300 miles of roads were paved in the Brazilian state of Mato Grosso last year, with an estimated 1500 miles more to be paved by 2006 (Diaz, 2004a). When Highway BR-163 is complete, its main users, Cargill, Archer Daniels Midland and Bunge, will finance the road through tolls.

Other infrastructure projects for transporting crops to markets include improving BR-634, the main highway linking western Mato Grosso and southern Rondônia to barge facilities at Porto Velho on the Madeira River (Shean, 2004). Additional partnerships could expand the port facilities at Itacoatiara and Santarém (Verdonk, 2003a).

Tax incentives, public–private partnerships and a 'fee-per-use' or toll basis are all alternatives for building Brazil's infrastructure to help bring soybean crops to market. Modern infrastructures could lower transportation costs by as much as $20 per tonne (Diaz, 2004a).

Regulatory oversight and labelling for addressing health and safety impacts

One of the most important aspects of creating viable policies on GMOs requires continual research and testing on the health and safety impacts of GMOs. With many countries banning GMO products, more research and testing is needed to achieve a better understanding of the intended and unintended consequences of GM products. Little research has been conducted scientifically to support GMO laws and regulations. Sound scientific research can be encouraged with viable incentives.

Research surrounding the health and safety effects of GM products is limited because:

> . . . *(bio)technology has been available for such a short amount of time, there is relatively little research which has been conducted on the long-term effects on health. The greatest danger lies not in the effects that we have studied, but in those which we cannot anticipate* . . . ' (Bates *et al.*, 2004).

While the long-term health effects of GMOs are not known, a lack of comprehensive research has created a great divide among nations over the safety and consumption of GM products. While GM products are widely used and accepted in the USA, Argentina and Canada, most EU countries and developing nations do not support their use. Interestingly, China is becoming a major trading partner, by importing 18 million tonnes of soybeans in the first 11 months of 2004, of which 31% came from Brazil and were worth $2.0 billion.

The Brazilian Government, by partnering with universities, NGOs and biotechnology firms, can conduct comprehensive studies on the health effects of GMOs more cost-effectively to retain a leadership position in producing and labelling GM products. A recent study conducted by Professors Pryme and Lembcke, published in *Nutrition and Health*, identified '. . . *only ten published studies of the health effects of GM food or feed*' (Pryme and Lembcke, 2003; Soil Association, 2003). Pryme and Lembcke (2003) found no negative health effects, whereas other studies found potentially negative health effects which could not be explained. Another study, in March 2004, by the British Medical Association, found that '. . . *genetically modified foods are unlikely to damage human health* . . . ' (*Reuters*, 2004a). Questions regarding the quality, adequacy and interpretation of many studies on GMOs remain. Brazil has an important opportunity to become one of the leading nations to conduct groundbreaking and extensive research into the health effects of GMOs. To enhance Brazil's standing, both domestically and internationally, it can partner with NGOs, universities, CTNbio, EMBRAPA and biotechnology firms to research the health effects of GMOs.

Another important policy issue facing Brazil is effectively labelling products containing GMOs. In July 2003, Brazil's Executive Order 4680 created a new labelling symbol for GM crops. This law required mandatory labelling for all food or food ingredients produced for human or animal consumption containing over 1% of GMOs by April 2004. Labelling

Figure 3. Brazil's proposed transgenic symbol.
Source: Silva, 2003b.

GM products are regulated by both the Ministry of Justice, Agency for Sanitary Surveillance (ANVISA) and the Ministry of Health (Silva, 2003b). Brazil created a new symbol for transgenetic materials (see **Figure 3**). In large part, to meet existing GMO regulations from the EU and China, two of Brazil's largest trade partners (Verdonk, 2003b). For Brazil to continue to trade with the EU, China and other developing nations, it must adhere to the strict labelling guidelines of its trade partners. Since Brazil has already developed the necessary systems, Brazilian producers will enjoy a significant short-term competitive advantage over many nations, including the USA.

A more difficult task for Brazil may be working with the international community to establish a common GMO labelling standard. Brazil, working through the UN, the EU and the WTO, can combine efforts to create a unified GMO labelling requirement. EMBRAPA has estimated that implementing a comprehensive labelling system would cost $350 million and an additional $50 million per year to maintain (*O Globo*, 2002). Within Brazil, many GM soy farmers argue that the costs of labelling and testing are marginal compared with the savings in herbicides (Smith, 2003). Brazil's rules on labelling food products, similar to those established by the EU, help the county align itself with other countries to push for mandatory labelling on a larger scale. Creating a powerful coalition of countries that require mandatory labelling may lead to widespread change and level the competitive field.

In addition to regulatory oversight and labelling policies, Brazil must gain the support of its people regarding the production and consumption of GMOs. Currently, a large portion of the Brazilian population is opposed to the use and export of GMOs. Without widespread public support, the country might lose the competitive economic advantages it currently enjoys. The Brazilian Government are able to create a balanced public awareness campaign to educate its citizens on the risks and benefits of GM products. Three recent developments are highlighted below.

First, a recent report by the Food and Agriculture Organization (FAO) of the UN argued that GM foods have the potential to alleviate global hunger, while rejecting as too extreme the position embraced by many environmental and advocacy groups (Gillis, 2004). Secondly, the EU lifted a six-year moratorium on importing GM foods by allowing entry of a new strain of sweet corn. Thirdly, China approved imports of GM soybeans from Brazil. The acceptance of Brazilian soybeans by China, which in recent years has tightened its GMO policy, could lead other sceptical nations to accept GM products. These three unrelated events provide Brazil with a springboard to lobby for greater acceptance of GM products, both at home and abroad.

By leveraging the local economic benefits of increased crop yields, meeting worldwide demands with soy exports and highlighting the benefits of foreign partnerships in keeping the profits local, the Brazilian Government can leverage its natural advantages in land mass and fertile soil. Building roads, improving seaports and creating better school systems can also provide the needed infrastructure, directly benefiting the citizens of Brazil.

Conclusion

Brazil now has a unique opportunity to implement a comprehensive GMO policy which includes environmental preservation, domestic research and testing, improving infrastructure and labelling, while increasing public awareness of the benefits and limitations of GM products. *If* it embraces, accepts and promotes GM crops and foods, Brazil can help to conserve the remaining rainforest, while providing jobs and sustainable economic growth. Brazil's ability to find an effective solution can help itself to develop systematic GMO policies. By helping itself, Brazil can also lead other developing countries with agriculture-based economies.

In Brazil, and in many nations of Africa, it is possible to reverse the growing trend of large mechanized commercial farms that are replacing the small, family-run farms.

> *Smaller farms produce, on the average, 100 to 1000% more total food per unit area than large farms. Great productivity gains could be achieved by reducing average size in most countries* (Food First, 2003).

GM crops, available to small family-run farms, could have worldwide ripple effects having an impact on urban infrastructures and preserving rural lifestyles. Many GM soybean varieties enable farmers to engage in 'reduced tillage practices' that cut the erosion of topsoil, an invaluable commodity in any agricultural-based economy—but particularly in Brazil's rainforest regions. Brazil has also effectively dealt with astounding increases in urban migration over the past 15 years. Inability to access credit, and vulnerability to Mother Nature, creates a precarious lifestyle for many small farmers worldwide. GM seeds can reduce inputs (e.g. herbicides, insecticides, fertilizers and irrigation) and minimize labour requirements for harvest, while creating crop varieties more resilient to changes in temperature, soil pH and precipitation. Quantifying and disseminating this potential opportunity to rural farmers, large multinational firms, food processors and consumers can begin the process towards a better understanding of GM foods.

Brazil has taken some important steps in creating comprehensive public–private systems and dedicating government agencies for establishing policy on the multi-faceted GMO issues. However, continuing to work towards a centralized regulatory framework to oversee the use, testing, labelling and commercialization of GM products is critical. Brazil's current regulatory system governing GMOs may hurt its market position. By partnering with universities, NGOs and biotechnology firms to conduct comprehensive studies on the health effects of GMOs, the Brazilian Government can lead the debate on testing and research. These studies can help to create a scientific database for the Brazilian population and its worldwide audience concerning the benefits and limitations of GMOs. Brazil has begun the process of developing a sound labelling standard, which will help their short-term position. However, pressing issues remain in processing, shipping and distribution infrastructure to move soy and agriculture products across Brazil in a sufficiently cost-effective manner. By successfully creating a comprehensive solution to the GMO issue, Brazil can develop a competitive advantage over other countries, including the USA, while experiencing economic and social growth, especially in its impoverished rural sector. Brazil is currently at a crossroads, and can now take a series of steps to position itself more strongly as a leader in the world market.

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