RECLAIMING MARGINAL LANDS AND EXPLOITING TROPICAL SOILS: THE CERRADO IN BRAZIL AND ITS FUTURE ROLE IN INTERNATIONAL TRADE*

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It is a pleasure and an honor to be on this program in which we honor our colleague Norman Borlaug. The energy and perspicacity of this man as he seeks to address the problem of food security around the world is incredible. Dr. Borlaug is not one who just talks about the problem. He gets out in the field and does something about it. I have often thought how insightful it was that he was awarded the Nobel Prize for Peace in recognition of his work in helping to feed the world. It is only now that we fully recognize that hunger and starvation are important causes of conflict in the world. How fortunate **we** all are that he has been able to sustain his work on behalf of the poor and the food insecure.

It is also a pleasure to be asked to discuss the challenge of reclaiming marginal lands and exploiting tropical soils, with special reference to the cerrado soils in Brazil. There is a quiet technological revolution taking place on the tropical soils of that country. Many of the current developments focus on soybeans, and pos a substantial international competitive trade threat to U.S. producers. But the revolution on the cerrado is much broader than soybeans, and is having a significant impact on the livestock industry as well – especially the cattle feeding industry.

The case of soybeans in Brazil is of special interest. The introduction and spread of soybeans in that country is of special interest as one thinks about capitalizing on marginal lands and exploiting tropical soils. But it is also very instructive in thinking about how new production technology gets transferred from one country to another, and in thinking about the complementarity between economic policy and science and technology policy as one thinks about development policy.

My comments are divided into three main parts. In the first part I will discuss the process by which soybeans were introduced into and spread within Brazil. Associated with that I will discuss the forces behind the shift in the production of this important crop from one part of the country to another. There are some important lessons to be learned from this process. In the second part I will discuss some of the other important agricultural developments on the cerrado soils. Finally, I will draw some implications from these experiences for addressing the larger food security problem the world faces.

The History of Soybeans in Brazil

I first went to Brazil in February, 1963. Before ever going to the University of Vicosa, where I would eventually be located for two years, I was taken to the Triangulo Mineiro, a highly productive area in the western part of the State of Minas Gerais, and to the new city of Brasilia. One of the lasting memories of that trip was a visit to the cerrado, and a lecture out in the field by a person who was introduced to us as the world's leading expert on the cerrados. For the uninitiated, the cerrados are tropical soils from which most of the productive nutrients have been leached out over the years, or have been tied up by chemical means. Although the quality of these soils varies a great deal from one region and classification to another, they are generally of low productivity – what one would call marginal lands.

The expert on the cerrados was from the University of Brasilia. He explained to us that the low productivity of the cerrado soils was due mainly to the lack of rainfall. He also reminded us of the vast areas of cerrado soils that Brazil had.

My mission in Brazil was to work with the University of Vicosa on a collaborative institutional development program between that University and Purdue University. Accompanying me on the trip from Purdue University

was the head of the Agronomy Department, who was an expert on soybeans. He was to be a short time visitor, and was given the assignment of verifying the potential of soybeans in Brazil.

An interesting feature of soybeans in Brazil at that time was that they were used primarily as a hay crop. That was consistent with my own experience, for when I was growing up in Indiana that was the main way we thought of soybeans.

Purdue eventually helped transfer some soybean lines to Brazil, and for that reason has received substantial criticism from U.S. soybean interests. The more interesting issue, however, is that Brazilian farmers were at that time traveling all over the United States buying up bushels of soybeans and shipping them back to Brazil to try them out on their fields. That was the basis of establishing soybeans in that country.

Another part of that early history is that soybeans proved to fit nicely as a double crop with the production of wheat in the southern State of Rio Grande do Sul. (See Figure 1.) This was an efficient complementarity, since the equipment required for the production and harvesting of both crops was the same. The resulting double crop system was called a doubradinho in Portuguese. A further advantage was that the heavy applications of fertilizers on the wheat carried over to the soybeans.

This proved to be a highly profitable combination and production increased rapidly. At about this time, the government was subsidizing rather heavily the production of wheat as part of its import substitution, food self-sufficiency program. This gave further impetus to the production of soybeans and Brazil began to make inroads into the international market that was at that time dominated by the United States.

It is worth noting that soybeans were at this time already responsible for bringing what could best be called marginal lands into production. Prior to adopting the double cropping system, the land essentially laid idle for an important part of the year. The new system brought the into production for a larger share of the year.

The production of soybeans gradually shifted to the north, up through the States of Santa Catarina, Parana, and into Sao Paulo. (See Figure 1 again.) Much of this shift involved the plowing up of pastures and the

planting to soybeans. Eventually, the production of soybeans settled in a significant way in the southern part of the State of Mato Grosso. This was a relatively new area with unusually fertile soils. Production of the crop continued to expand and exports continued to rise. It was a dramatic day in Brazil when the foreign exchange earned from the exports of soybeans surpassed the exchange earnings from the exports of coffee. It was dramatic because Brazilians had always been trade pessimists and had little confidence that they could compete in the international economy. Now they had taken away a significant share of the U.S. market for this important commodity.

Another part of the story at this time was that Brazil had adopted export-enhancing policies as it struggled to service its foreign debt. An important part of those policies was the provision of subsidies for the processing of oils and meal from the raw beans. This provided an added stimulus to the production of soybeans, and left a lasting impression on the composition of the export mix.

The next stage in the evolution of the industry was the discovery that cerrado soils could be made significantly more productive by the application of modest amounts of lime and modest amounts of phosphorous. The potential of this development was rooted in the large areas of cerrado soils that are relatively flat and lend themselves to mechanization. The payoff has been great. Moreover, it has been reinforced by the development of improved varieties of soybeans that are especially adapted to the tropical soils and conditions.

Policy makers have exploited the potential of this crop by constructing penetration highways into the newly opened areas, by building a floating port at Manaus, where the Amazon River fluctuates by 30 to 35 feet as the tides change, and by making navegable the Rio Madeira. The Rio Madeira is a river of approximately the same size as the Mississipi River in the United States, and has the advantage of having no locks! It empties into the Amazon River at a point where the Amazon is seven miles wide.

As we can see, the whole configuration of the transportation of soybeans has changed. Rather than to go south and be loaded on ocean-going vessels in the southern tip of the country and then going all around the cape or up the Atlantic Ocean, the production now goes out through the

Amazon River and directly across the Atlantic or through the Panama Canal and off to Asia. The reduction in costs is substantial.

The significance of these developments is that Brazil has over a hundred million acres of cerrado soils that are still under-exploited. The potential for further expansion is huge. In addition, there are other soils around the world that are very similar to the cerrados. These include the llanos in Colombia, and the savannah soils in Sub Saharan Africa.

Other Developments on the Cerrado

The improvement of the soybean is not the only story of the cerrado in Brazil. A short trip down the road from Brasilia to Belo Horizonte will take one through an area in which coffee, rice, maize, and other crops are being grown. It wasn't many years ago that that land was almost pure cerrado, with the clear implication that it was marginal in just about any way you wanted to think about it. It was extensively exploited if at all.

Another development on marginal lands is on the cerrados around the City of Campo Grande in the state of Mato Grosso. This was a classic area of low productivity cerrado soils. Beef cattle were grazed very extensively, on natural pastures, and it typically took four to five years to get them to market as they gained and lost in sequence as they moved through the annual weather cycle.

Developments with the cerrado soils have changed all of that. The application of lime and phosphorous increases the productivity of the soils by four to five times. That makes it possible to plant more productive artificial pastures and to feed the animals much more intensively. The Brahma cattle are crossed with Limousin, Simentel, or other European breeds and the young cattle are taken to market in 18 months. The intensification in land use is very significant. Recall again that these were at one time referred to as marginal lands.

To witness these technological revolutions first hand is impressive. Artificial insemination has spread throughout the region. Embryos can be purchased based on some of the best bloodlines in the world. And Brazil has now begun to export beef (over $1 billion last year) in competition with the United States and other exporting countries.

Some Lessons and Implications

One of the interesting features of the soybean industry is its rapid growth all around the world. In fact, there are certain ironies in an analysis of the data. For example, most observers in the United States believe that most of our competition comes from Brazil. However, Table 1 and Figures 2 and 3 show that not to be the case. First, one can see that production in the rest of the world – outside of the United States and Brazil, is expanding at a faster pace than in Brazil. In fact, the United States is not doing so badly in any case! Expansion of production in the United States is greater in absolute amounts than in the rest of the world – including Brazil.

The outlook for the future is another matter, of course. The production potential in Brazil is huge. And it includes more than just soybeans.

A second important point from observing the evolution of this sector is the role that agricultural research can play in bringing marginal lands into production. Research on the tropical soils has been relatively limited in the past. Most of the agricultural efforts has been concentrated on plant breeding. The Brazilians have distinguished themselves by concentrating on the tropical soils. Making the cerrados productive has been a significant breakthrough.

It wasn't just research on the soils, however. EMBRAPA, the national agricultural research system in Brazil, also worked on improving the varieties of soybeans and making them more adaptable to the cerrado soils. The interactions between the two breakthroughs has been very significant.

There is another dimension to this issue, especially when one thinks about the international division of labor and specialization. There was a time when it appeared that producers in the United States did not have to worry about the inroads being made by the Brazilian industry. Brazil was far from being competitive in the international market for maize, but the United States was. It seemed clear at that time that the United States would eventually specialize in the production of maize and Brazil in the production of soybeans.

The world has changed again, however, and largely in response to additional research on plant breeding – much of it by the private sector. Brazil is now making significant inroads in improving the yields of maize. In fact, it appears that Brazil is going to become very competitive internationally in that crop as well.

My perception is that South America is going to become a significant competitor in the international markets for a number of our major commodities. We have seen what Brazil can do. Another interesting country nearby is Argentina – a country that insists on counter-productive trade and exchange rate policies. That country has exceptional lands in the Pampas – an area of almost unlimited agricultural potential.

Economic policy discriminates severely against agriculture in that country. However, the production of soybeans continues to grow, despite the discriminatory policies. And interestingly enough, the varieties from the United States are quite suited to the soils and climate in Argentina. If Argentina had a more efficient set of economic policies, soybeans would be increasingly significant in that region.

Of course, Brazil is not the only country in which the new technology can be adopted. Sub Saharan Africa has an impressive amount of what are called savannah soils. These are very similar to the cerrados, and may be potentially more productive in the same way the marginal lands of Brazil have become. Closer to home, there are the llano soils of Colombia, which are also very similar.

When one thinks about these vast areas of what are now considered to be marginal lands and their potential for feeding the world, a logical question becomes whether we need to invest in agricultural research on the same scale as in the past. On this issue we need to be careful not to delude ourselves. There is a lot we don't know about tropical soils. The lesson we learn from the experience with tropical soils is that it was investments in agricultural research that enabled us to bring these marginal lands into production. Moreover, the experience in Brazil makes it clear how important the investment in plant breeding can be in raising the productivity of the soils.

There is still another way of thinking about this process. We know that even in countries such as Brazil in which there are neither land nor labor

constraints inhibiting the development and expansion of agriculture, the social rate of return to investing in agricultural research is very high. Compared to other forms of public investments, it pays to invest in agricultural research.

One of the reasons the rate of return on investing in agricultural research is so high is that everybody consumes food. When the diffusion of agricultural technology brings down the real price of food, the per capita incomes of everybody increases. Socially, the significance of that is that poor people benefit in a relative sense. There simply is no other way that the poor can be benefited so much in a relative way as by the investment in agricultural research. The puzzle is why the international donor community, with all its rhetoric on poverty alleviation, has such great difficulty in recognizing this important point.

Concluding Comments

Investments in agricultural research, and much of it in the relatively neglected area of tropical areas, has made it possible to bring large areas of marginal tropical soils into production. Most of these investments were made by a low income, developing country. This research makes it possible to bring into production large areas of land that would otherwise have been outside the national economy. Moreover, it has created a powerful source of economic growth and development with the potential to raise the per capita incomes of millions of poverty-stricken people. The lessons from this experience are powerful and pervasive. Let's hope that we take heed of them.