

**Draft Final Report  
for Comments**

**Land Use Trends in Paraguay and the Northern Chaco**

**Prepared for World Land Trust and Guyra Paraguay**

**by**

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(satellite imagery)**

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## **I - Overview of the Paraguayan Economy and Drivers of Growth**

The Paraguayan economy has long been based on agriculture and commerce. Traditional agricultural exports in the colonial period included cotton, tobacco and yerba mate. Following the War of the Triple Alliance (1865-70), which resulted in the decimation of the adult male population, millions of hectares of government land were sold to foreign investors who developed large estancias for cattle raising in the Eastern Region and for the extraction of quinine for leather tanning in the Chaco Region along the Paraguay River.

Due to Paraguay's landlocked position and relative isolation, the economy was somewhat shielded from the ups and downs of the world; indeed, during the depths of the Great Depression, the Paraguayan economy grew at 8 percent in the mid-1930s, in part, spurred by forces of self-survival during the War of the Chaco with Bolivia.

At the start of the Stroessner regime (1954-89), the economy was still heavily oriented towards agriculture, although much of the territory had still not been exploited. In 1960, one-half of the Eastern Region (8 million hectares of a total 16 m hectares) remained as forest. The Chaco Region, which comprises 24 million hectares, remained largely undeveloped except for the area of Mennonite colonies in the central Chaco, and the original forest cover in the Chaco remained largely intact.

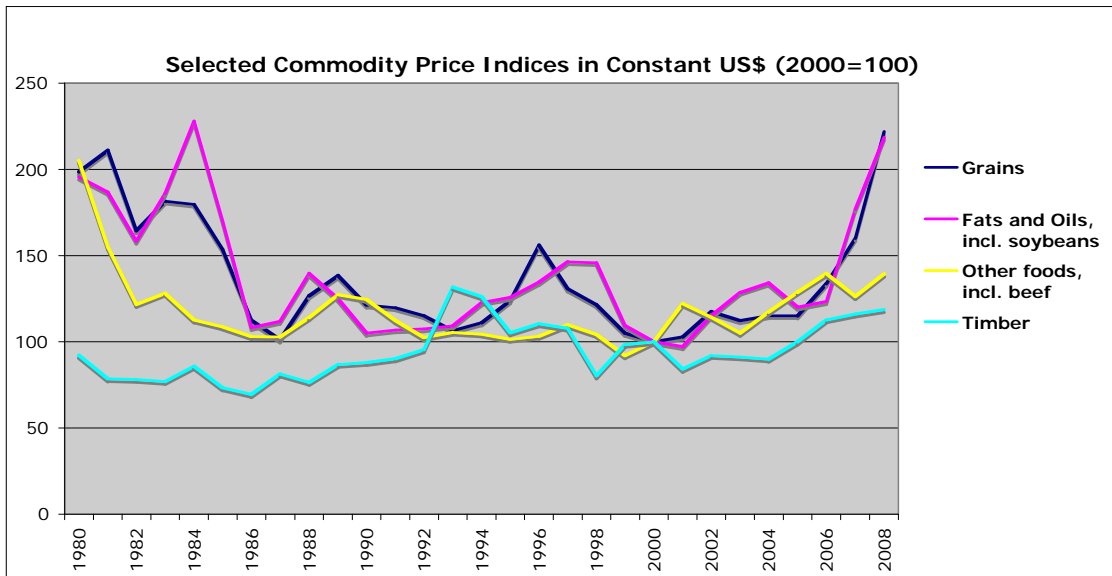
In 1963 the Government adopted a program of "agrarian reform." This program was more aimed at opening the agricultural frontier, however, than at redistributing land to landless peasants. The philosophy of the program can be characterized by the fact that it considered forest to be "unproductive" land and an impediment to development. The program awarded up to 1,500 hectares to qualified individuals for cattle ranching in the Eastern Region and up to 8,000 hectares for ranching in the Chaco. The clearing of forest was implicitly considered a civic duty and was an inevitable result of the program.

During the following forty years, the agrarian reform distributed 11.9 million hectares (29% of the national territory), which was practically all of the remaining government lands (*tierras fiscales*). Of the total, 8.8 million hectares were large plots (over 100 has. in the Eastern Region and over 1,000 has. in the Chaco) that went to a small number of 4,086 individuals who received an average of 2,160 hectares each. The other 3.1 million hectares went to 160,000 smallholders, for an average of 19 hectares each.

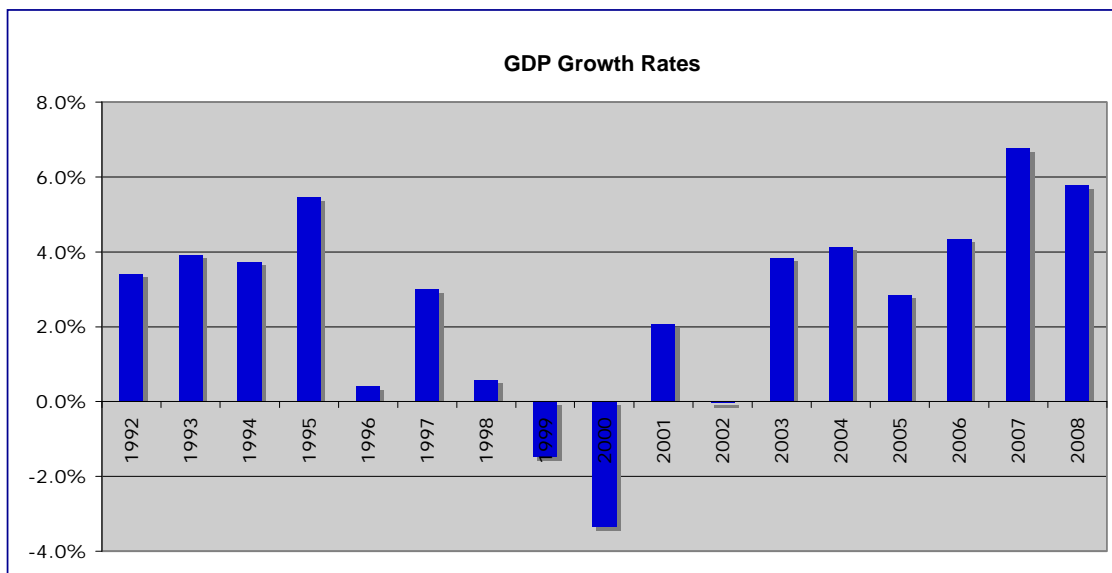
The program was reformed in 2002 and now limits distributions to a maximum of 20 hectares in the Eastern Region and 100 hectares in the Chaco. The lack of *tierras fiscales* severely limits the program, however, and the Government has had to purchase most of the land it distributed in recent years.

Importantly, the new law no longer considers forests to be "unproductive" land. Also, in 1973, the basic law governing forestry in Paraguay established a minimum forest reserve of 25 percent for all agricultural / ranching lands, but control has been ineffective and actual reserves are much less. At present, there are only 1 to 2 million hectares of forest in the Eastern Region, depending on whether degraded forests are included or not in the definition of forest.

Against the above overview of land use change and distribution, the economy experienced several rounds of boom and bust. Perhaps the most important was triggered by the construction of the Itaipú hydroelectric dam on the Paraná River, jointly with Brazil, in the 1970s and early 1980s. This coincided with the commodity price boom of the 1970s, and the economy grew strongly during this period, 8-12 percent per year in some years. In addition to agriculture and construction, commerce became increasingly important, especially in terms of re-exporting imported consumer goods to Argentina and Brazil. Growth slowed in the later half of the 1980s, due to distortionary exchange rate and financial policies, as well as an easing of commodity prices.

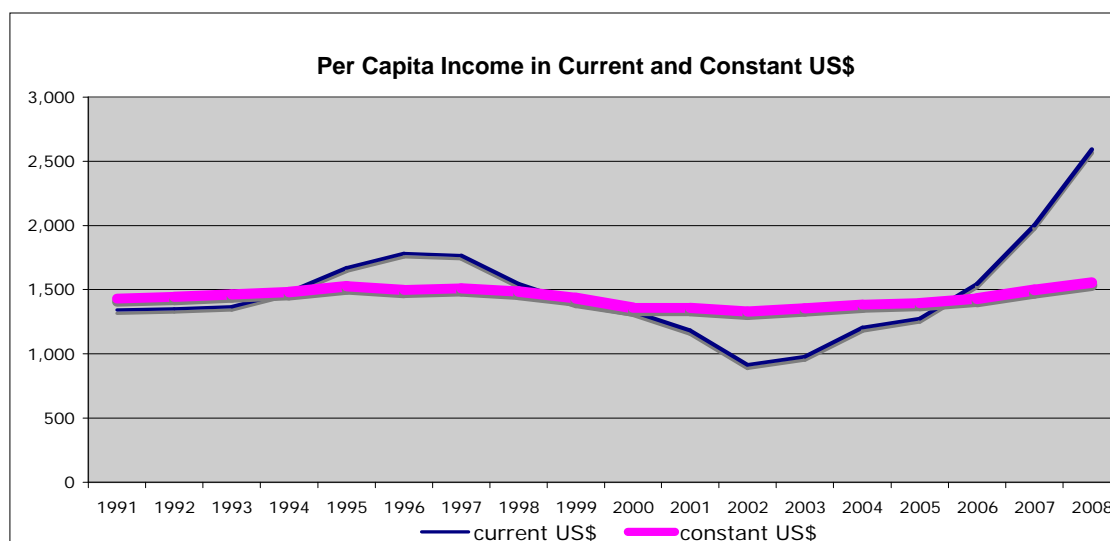


Following the overthrow of the Stroessner regime in 1989, the economy experienced another round of growth in the early 1990s, followed by five years of stagnation due mainly to poor economic policies, and then strong growth since 2003 due to much improved economic policies and the most recent boom in commodity prices.



Period Average Growth Rates (%)		
	GDP	GDP per capita
1991 - 1997	3.3%	0.9%
1997 - 2002	-0.4%	-2.5%
2002 - 2008	4.6%	2.7%

On-and-off economic growth, combined with population growth of about 2 percent per annum, has left income per capita essentially unchanged over the past two decades at about \$1,500 in real terms. In current US\$, per capita income decreased sharply to \$915 in 2002 due to depreciation of the exchange rate (to a low of Guaranies 7,000 per US\$), as a result of fiscal imbalances and poor economic policies. Per capita income subsequently recovered and rose to an all-time high of about \$2,500 in 2007, reflecting a significant appreciation of the exchange rate (to Guaranies 4,000 per US\$) due to tighter fiscal policies, a significant increase in workers' remittances and much higher commodity prices.



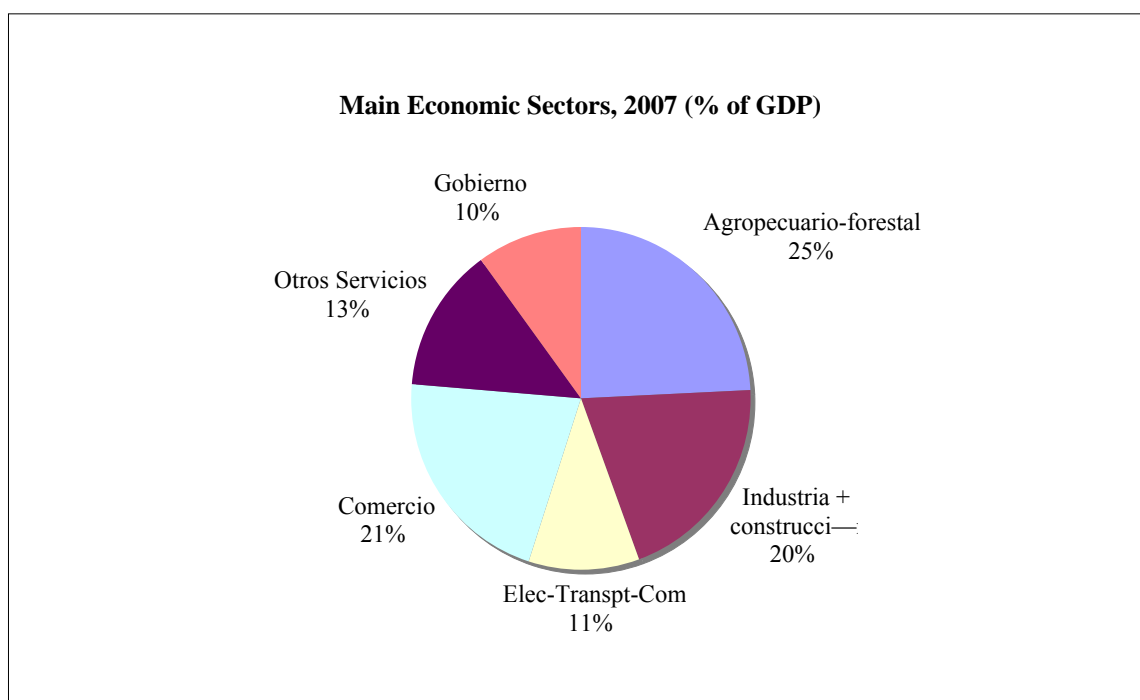
Total GDP in US\$ has also varied considerably over the past years reflecting fluctuations in the exchange rate. At the current rate of about Guaranies 5,000 per US\$, total GDP is about \$14 billion and GDP per capita about \$2,300. Paraguay is categorized as a “lower-middle income” country by the World Bank and has social indicators about average for this group, e.g., 72 years life expectancy, 77 percent access to improved water, and full primary school enrollment (although secondary school enrollment is low).

In recent years, agriculture and cattle ranching have been the leading economic sectors with growth rates of 6.5 percent and 4.2 percent per annum, respectively, during the 2000 – 2008 period, compared with overall GDP growth of 2.9 percent per annum. Transport has also grown at similar rates, accompanying the needs of the agriculture sectors. In addition, Paraguay experienced high growth in telecommunications, 5.9 percent per

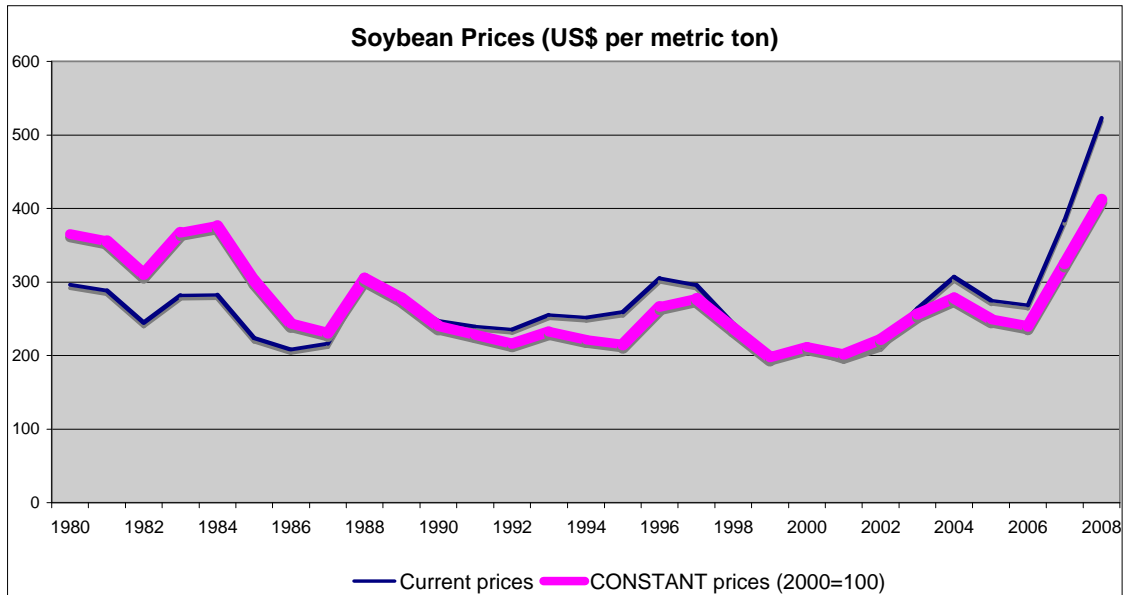
annum, reflecting the growth of cellular telephones. In contrast, growth in industry and commerce has lagged overall GDP due to restrictive *de facto* trade policies of Mercosur, which provide high protection to Argentine and Brazilian industries and obstruct the entry of Paraguayan goods into those markets.

<b>Leading Economic Sectors</b>	
<b>Average Growth Rates, 2000-2008 (%)</b>	
<b>Leading Sectors</b>	
Agricultura	6.5
Ganadería	4.2
Electricidad y agua	3.8
Transportes	5.2
Comunicaciones	5.9
<b>Gross domestic product</b>	<b>2.9</b>
<b>Lagging sectors</b>	
Industria	0.7
Construcción	1.9
Comercio	2.6
Gobierno general	1.5

As a result of the above growth patterns, agriculture and cattle ranching now represent about one-quarter of GDP, followed by commerce at 21 percent of GDP.



Growth in agriculture has been spurred by increasing world prices for agricultural commodities since 2000. The increase in the categories of grains and fats & oils (which includes soybean) has been particularly sharp -- see first graph on page 4. The following graph shows the yearly average world price of soybeans, which has doubled in real terms since 2000.



Although soybean prices fell sharply in late 2008, they have since recovered to about their average 2008 level and remain at historically high levels.

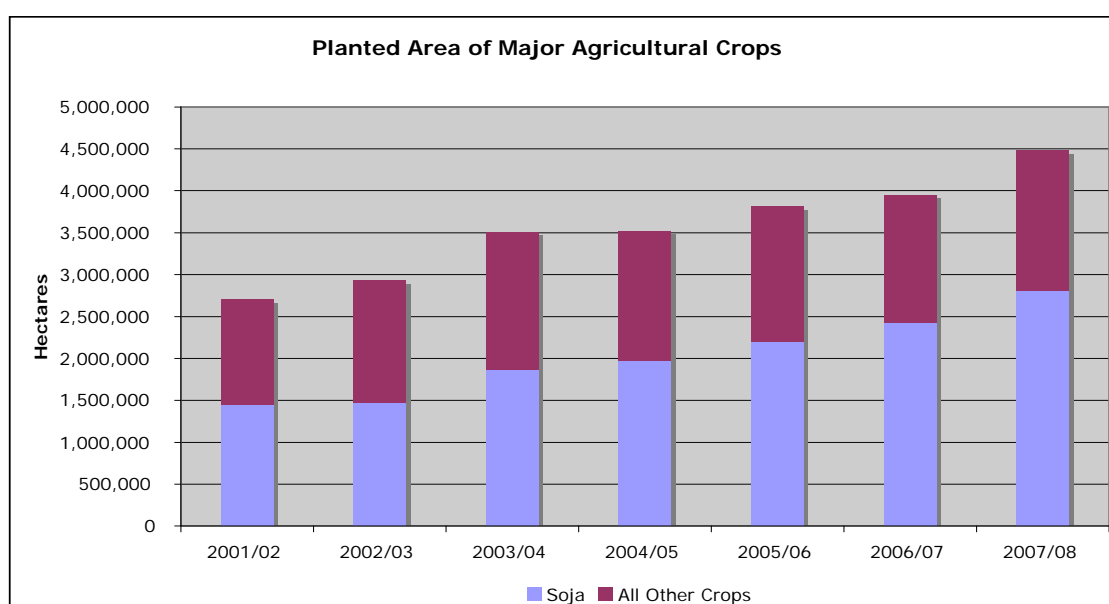
#### **Soybeans, Chicago Board of Trade, June 2007 through June 10, 2009**

Soybeans have become the crop of choice for commercial farmers in Paraguay. This is due to very rich, red-earth soils in the Eastern Region, considerable rainfall (1200 to 1800 millimeters per annum) and long growing days associated with Paraguay's sub-tropical latitude. Due to relatively cheap land prices in Paraguay, many Brazilian farmers have purchased land in the Eastern Region, especially in the Departments adjacent to Brazil,

namely, Alto Paraná, Itaipúa and Canendeyú. These “Brasi-guayos” have been one of the principal factors in the expansion of soybean production in Paraguay.

The most recent National Agricultural Census indicates that the area devoted to soybean production increased from 553,000 hectares in 1991 to 2,464,000 hectares in 2008 (see table in following section on land use patterns at the national level). This is an increase of 345% percent over 17 years, equivalent to a growth rate of 9.2% per annum.

Ministry of Agriculture crop sample data indicate that 2,800,000 hectares were devoted to soybean production in the 2007/08 planting season (see table 3 in the Statistical Appendix). According to this data, soybean acreage has risen from 54% of total planted area in the 2001/02 planting season to 63% of total area in 2007/08. Total production was estimated at 6,880,000 MT, placing Paraguay as one of the largest soybean producers in the world, and the fourth largest soybean exporter.

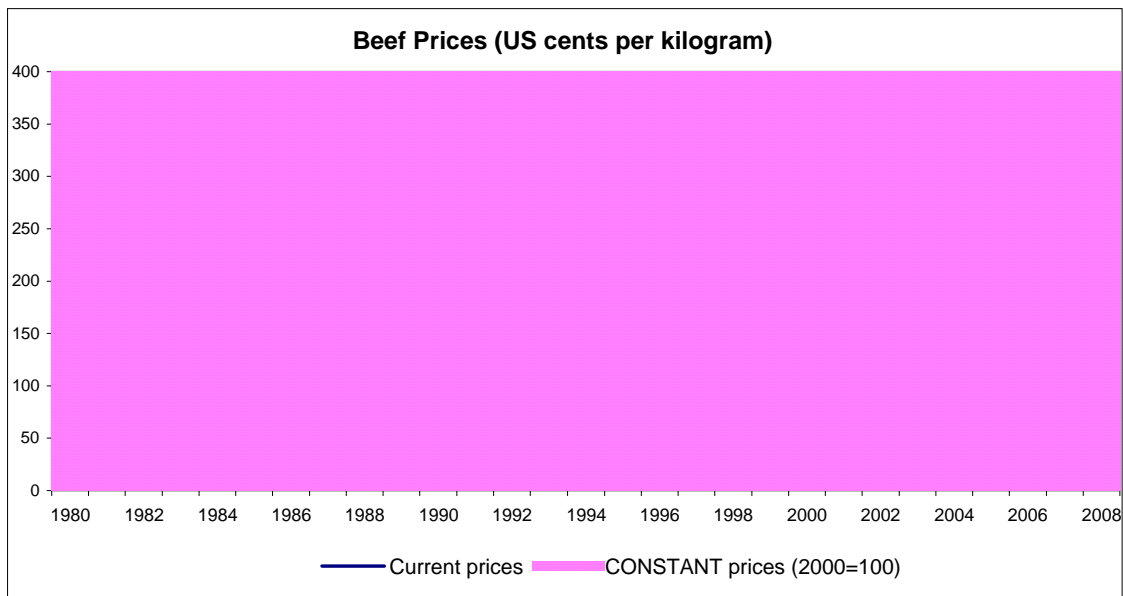


The other major crops are maize, manioc and wheat, each with about 8 to 10% of total planted area.

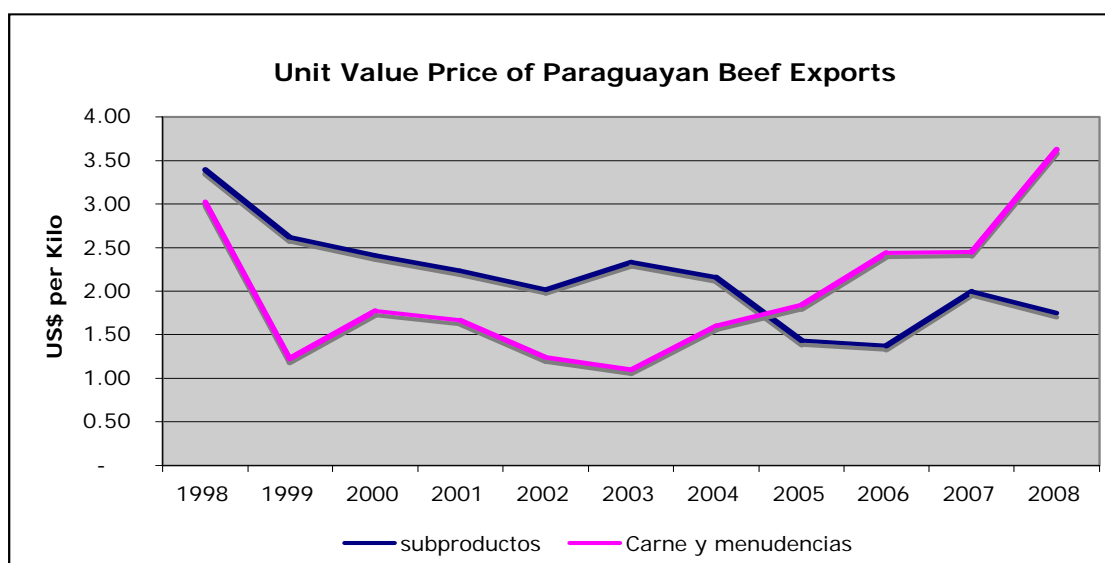
Planted Area of Principal Crops in 2007/08		
	Superficie (ha)	Porcentaje
Soja	2,800,000	62.5%
Ma'z	490,000	10.9%
Mandioca	370,000	8.3%
Trigo	320,000	7.1%
Girasol	109,000	2.4%
Ca—a de azúcar	97,000	2.2%
Algodón	95,000	2.1%
Poroto	85,000	1.9%
Arroz c/ riego	70,000	1.6%
Man'	37,000	0.8%
Tabaco	8,000	0.2%
Total	4,481,000	100.0%



The other major driver of growth in the agropecuario sector has been cattle ranching, which similarly has been spurred by rising world beef prices. Although world beef prices haven't risen as sharply as soybean prices, they have trended steadily upwards since reaching a low in 1996. See table 4 in statistical appendix for details.

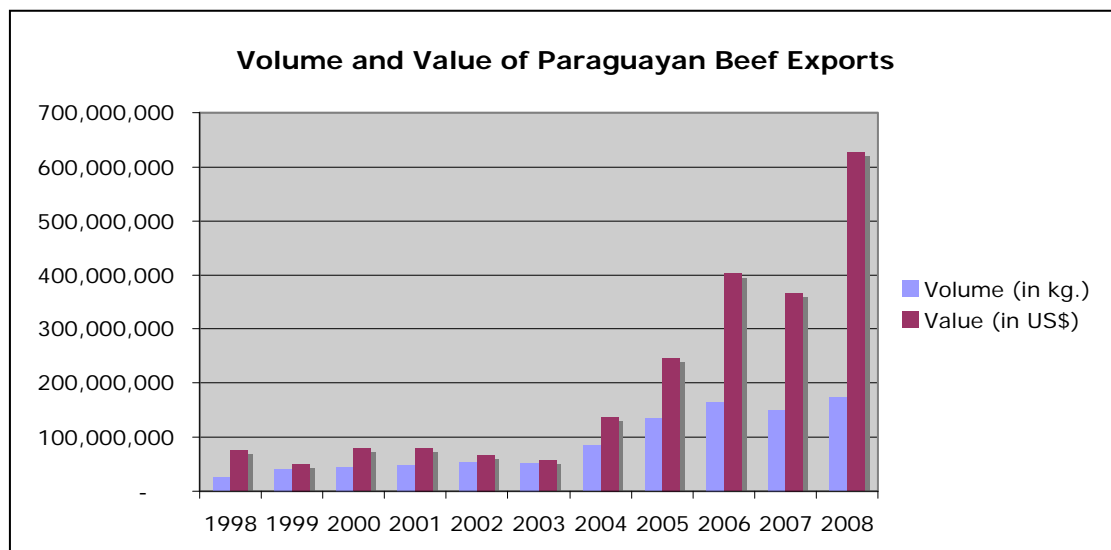


The trend in the above chart of world beef prices is similar to the trend in actual prices received by beef exporters in Paraguay for “carne y menudencias,” as reported by SENACSA (see table 5 in statistical appendix). The two sources differ in absolute values due to the specifics of Paraguayan exports and the exchange rate, but coincide in 2006 and 2007 with world beef prices about equal to the Paraguayan export price of about \$2.50 per kilo.



With rising world beef prices, Paraguayan ranchers responded by increasing the size of their herds. The National Agricultural Census data indicate that the number of cattle in Paraguay increased by 3.0 million head in 17 years, from 7.6 million in 1991 to 10.6 million in 2008 (see table in following section). The rate of increase, about 1.9% per annum, was much slower than the rate of increase in acreage devoted to soybean production, but the impact of expanded ranching on actual land use was much greater, as discussed in the following section. The increase in the national herd was about evenly split between the Eastern Region and the Chaco, with about 1.5 million head increase in both regions.

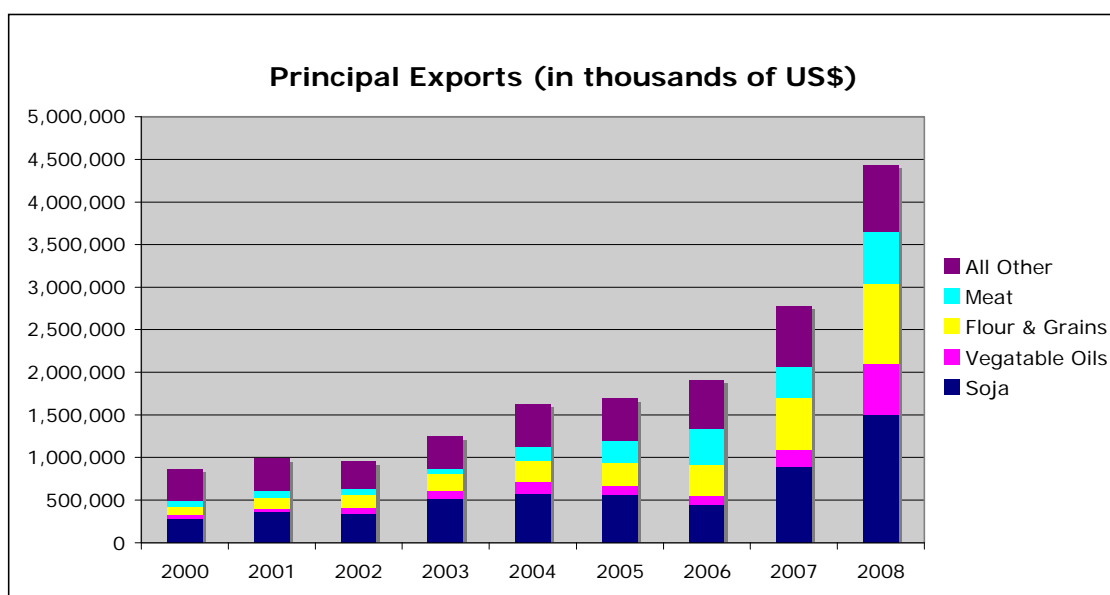
With rising cattle production, and more attractive world prices, Paraguayan beef exports rose in both volume and value. The volume is now about three times its level at the beginning of the decade, up to about 150,000 MT per annum in 2006-2008. In part, this increase was due to a concerted effort by Paraguayan ranchers to achieve zero foot-and-mouth disease status (with vaccination), and by the meat processing plants to comply with international sanitary standards, e.g., European Union eligibility for “quota Hilton.”



The US\$ value of beef exports reached a record level of \$600 million in 2008. Beef prices have retreated by about one-third in 2009, but are still attractive by historic standards.

The value and composition of all of Paraguay’s merchandise exports (excluding electricity from the hydroelectric dams) is shown in the graph on the following page. The increasing importance of soybeans (*soja*), meat and other agricultural products can be readily seen. Of additional note is the increase in exports of vegetable oils, which are based on soybeans and are indicative of a welcome increase in the industrial processing of foodstuffs.

Also of note is the very small share of “all other” exports (18% in 2008), which include other agricultural products such as cotton, sesame, timber and the few industrial goods that are exported. At present, Paraguay is still very much an exporter of agricultural products and is likely to remain so for the foreseeable future. Overall economic growth rates could be enhanced with additional processing of these products.



The spike in agricultural commodity prices in 2007 – 2008 exaggerated the share of agricultural products in Paraguay’s export revenues during the past two years. Commodity prices have now fallen back to less exaggerated levels due to the international financial crisis of late 2008 and early 2009. Paraguay export revenues are thus likely to be somewhat lower in the next few years. However, once the world economy is back on track, the expectation is that rising demand for food from the rapidly growing large emerging economies, in particular, China and India, will renew the pressure on agricultural prices and continue to spur demand for additional production in Paraguay.

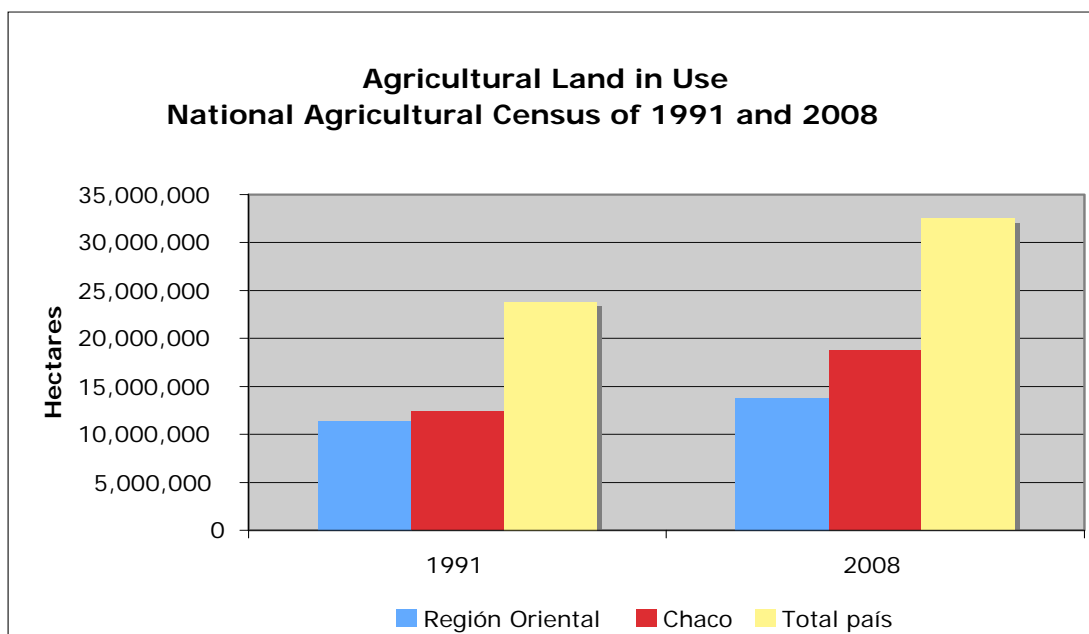
To summarize this section, in recent years economic growth in Paraguay has been driven by world demand for agricultural products, in particular soybeans and beef. Production of these commodities has expanded significantly along with the associated use of land for these purposes.

## II - Land Use Trends at the National Level

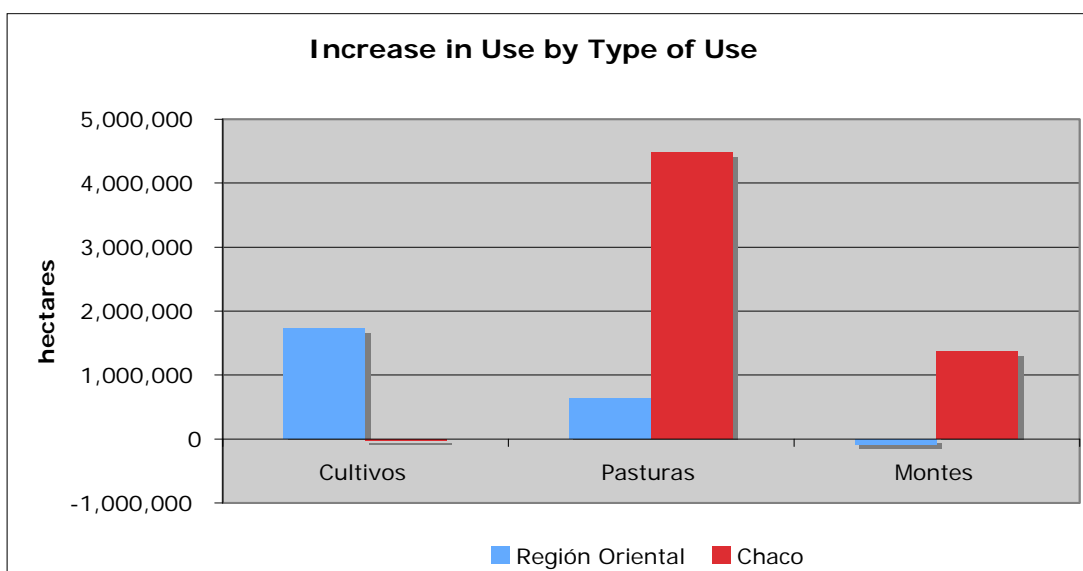
There are few sources of data on land use in Paraguay. A National Agricultural Census was taken in 1991 and again in 2008. In the intervening years, the Ministry of Agriculture makes estimates of land use based on limited sampling methods.

The full censuses aim for complete coverage of all agricultural “establishments” (farms) greater than 0.5 hectares. The results are analyzed by size of farm and type of use given to the land. Selected summary data pages from the 2008 Census are provided in tables 7 and 8 of the statistical appendix. A summary of the key data is contained in the graphs and table on the following pages.

The first conclusion of the 2008 Census is that agricultural land in use increased by 8.7 million hectares (37%) between 1991 and 2008, from 23.8 to 32.5 million hectares, equivalent to 80% of the national territory (40.68 million hectares).



The increase in land use occurred mainly in the Chaco Region, where land use increased by 6.4 million hectares. The additional land use in the Chaco was entirely for cattle ranching. Indeed, cultivated lands for crop use in the Chaco actually declined by a marginal amount. The additional ranch lands in the Chaco were dedicated mainly to pastures (4.5 million hectares), while an additional 1.4 million hectares of “*monte*” (forest reserves associated with the cattle ranches) was considered to be in active use by the Census.

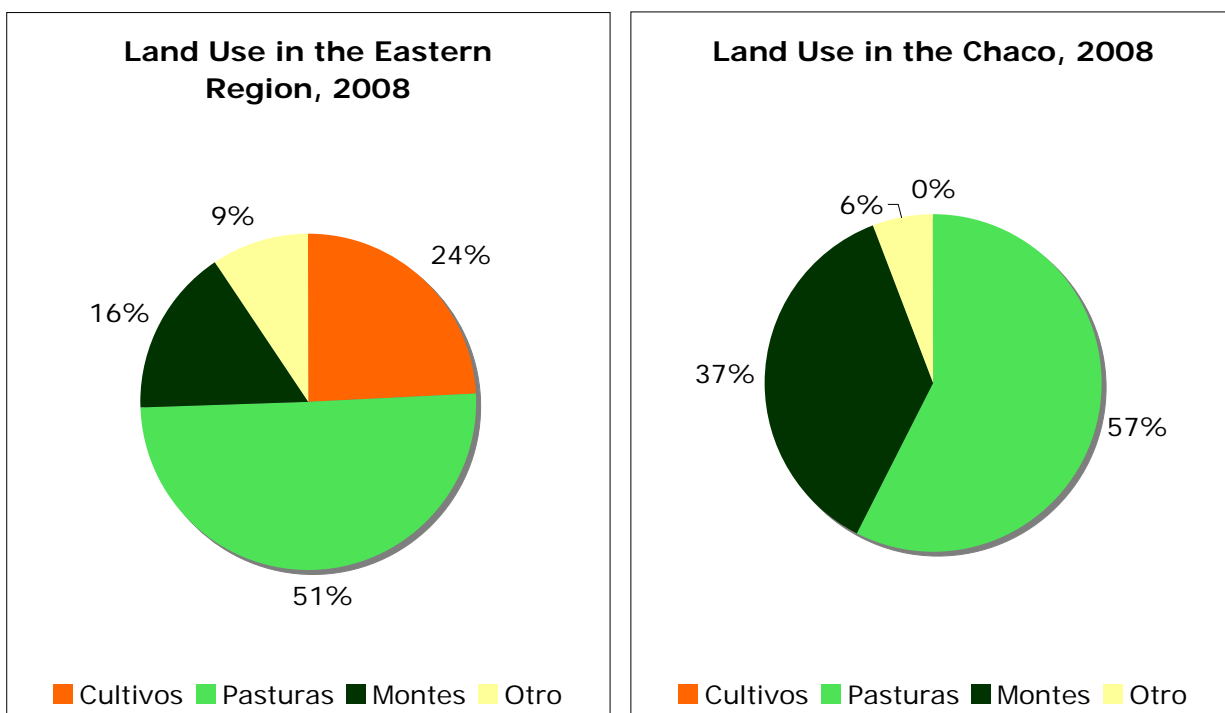


In the Eastern Region, land use expanded by 2.3 million hectares, which was dedicated mostly to cropland (1.7 million hectares) and the rest to pastures (0.6 million hectares). The expansion of cropland in the Eastern Region coincides almost completely with the expansion of soybean cultivation registered by the Census (1.9 million hectares).

Seventy percent of soybean cultivation was concentrated in three Departments -- Alto Paraná (30%), Itapúa (20) and Canindeyú (19%).

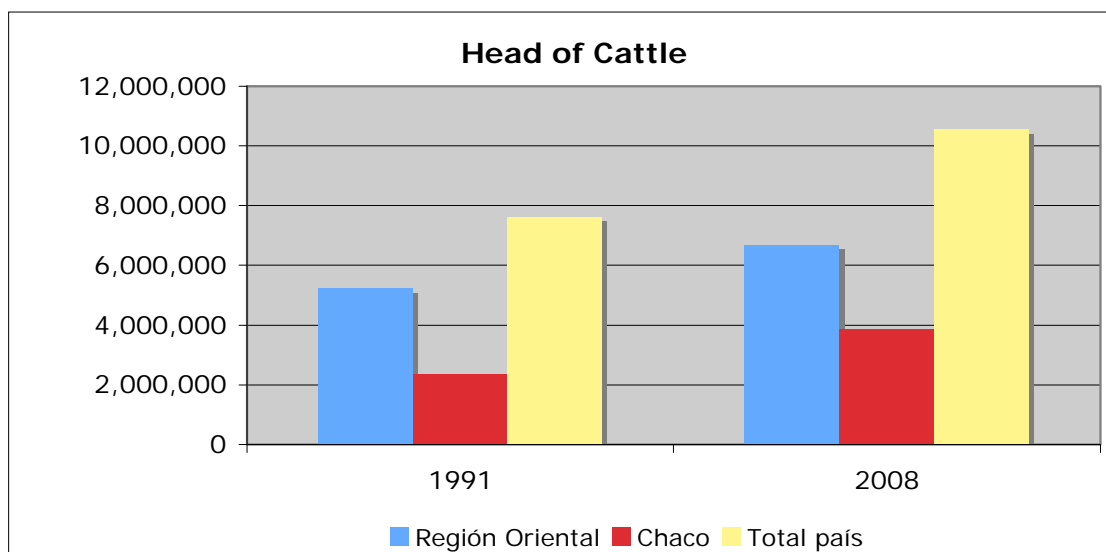
An interesting and important fact from the 2008 Census is that almost all of the additional land use in Paraguay (97% of the total increment) was recorded in farms of more than 500 hectares. This pattern applies to both the Eastern Region and the Chaco. The conclusion is that the increase in land use was driven almost entirely by commercial agriculture and ranching. Rising world prices for agricultural commodities and beef drove the expansion of land use, not redistribution of land to smallholders. Indeed, total land held by smallholders (farms of less than 100 hectares) actually declined by 15% between 1991 and 2008 -- see table 7 in statistical appendix -- as did the number of smallholder farms.

The current pattern of land use is shown in the following graphs. Almost all cultivated land for crop use is in the Eastern Region where it occupies nearly one-quarter of agricultural land. Pastures occupy one-half of agricultural lands in the Eastern Region, while *montes* (i.e., forest reserves for agricultural and pasture lands) occupy 16%, clearly less than the required 25% reserve. Fallow and/or unused land occupies the rest of the farm areas.



Farmland in the Chaco is dedicated almost exclusively to ranching, divided between pastures (57%) and *monte* (37%). From an overall perspective, it appears that the existing forest reserves exceed the required 25% of total farm area in the Chaco. This view is not conclusive, however, as the pattern of development in Alto Paraguay does not appear to have maintained the required forest reserves in many areas, as discussed in the following section.

The Census also provides interesting data on the intensity of land use for cattle ranching. As previously mentioned, the number of cattle increased by about 1.5 million head in both the Eastern Region and the Chaco.



However, due to very different soils and levels of rainfall, ranching in the Chaco occupies two to three times the area of pastures per head of cattle than in the Eastern Region. The red soils and higher levels of rainfall in the Eastern Region (see Map 1) support pastures apt for more intensive methods of ranching. Also, the use of implanted pastures with high-yield varieties of grass seed and the use of feedlots is more widespread in the Eastern region. For these reasons, ranchers in the Eastern Region were able to increase their herds by 1.5 million head with only an additional 0.6 million hectares of land. Overall, the number of hectares needed to support one head of cattle declined from 1.2 hectares in 1991 to 1.0 hectares in 2008.

Carrying Capacity by Region			
	Hectares of Pasture	Head	Hectares per Head
<b>Eastern Region</b>			
1991	6,266,341	5,237,892	1.2
2008	6,907,801	6,690,002	1.0
<b>Chaco</b>			
1991	6,305,554	2,388,725	2.6
2008	10,777,819	3,871,892	2.8

Ranchers in the Chaco, however, increased their pasturage by 4.5 million hectares to support the same 1.5 million head increase in their herds. Overall, the number of hectares of pasture used to support one head increased from 2.6 hectares in 1991 to 2.8 hectares in 2008.

There are several factors that contribute to this high land to cattle ratio in the Chaco and require ranchers to keep a reserve of pasture to deal with the eventualities of weather and poor roads:

- The seasonal flooding of natural pastures along the Chaco side of the Paraguay River requires moving cattle to higher ground.
- Most ranches in the Chaco are located far from all-weather roads -- only the road from Asunción to the central Chaco is paved -- and become isolated when it rains, especially in terms of access for trucks that transport cattle, usually 40 head at a time. When wet, the heavy clay soil of the Chaco turns soft and impassable. The soil does not drain well, and access roads often remain closed for weeks at a time. Ranchers in these areas have limited windows of time to send cattle to market and maintain a reserve of pasture to support their cattle until they can be shipped.
- Long distances make it costly to truck-in supplemental feed (sugarcane, for example) when drought strikes and pastures are no longer adequate for the cattle present. Ranchers thus keep a lower level of stock to reduce the impact of drought.

To counter these factors and improve productivity, ranchers in the Chaco are increasingly planting “artificial” pastures with high-yielding grasses, as is done in the Eastern Region. This is especially the case for new ranches that are being established in Alto Paraguay where implanted pastures can support up to one head per hectare.

The increase in the land to cattle ratio in the Chaco may also indicate that ranchers are using the profits of recent “fat” years to invest first in establishing new ranches with the expectation of increasing the stock of cattle per hectare as and when their finances permit and as the availability of young cows for fattening improves (an actual constraint on the growth of ranching in Paraguay).

Despite the lower overall carrying capacity of land in the Chaco, ranching is nevertheless financially attractive due to the lower cost of land, e.g. \$100 to \$400 per hectare depending on the zone and access to road infrastructure, versus \$500 to \$1,000 per hectare for land in the Eastern Region. Also, the Chaco soils are extremely rich in minerals, which is important for building large body frames in calves and lies behind a traditional pattern of raising calves in the Chaco and shipping them to the Eastern Region for fattening. Mineral rich soils reduce costs by not having to provide mineral supplements.

To summarize this section, the increase in land use for agriculture and ranching between 1991 and 2008 has brought Paraguay close to the limits of its agricultural frontier, with 80% of the national territory now devoted to these purposes. (National parks, wetlands, rivers, sand dunes on the boarder with Bolivia and urban areas occupy much of the remaining 20%.) The addition of 4.5 million hectares of pasture in the Chaco during this period has been the major contributor to deforestation in this Region, as well as in Paraguay as a whole.

Given the overall land constraint, further increases in agricultural production will have to be based on more intensive methods of farming and ranching than in the past, including higher levels of technology in order to increase productivity. Although there remain some areas of the Chaco suitable for expanding the area of cattle ranching, intensification of the ranching model will inevitably be needed to meet demands for higher beef exports.

The table on the following page summarizes the key results of the 2008 Census discussed above.

### Summary of 2008 National Census of Agropecuario Establishments

	1991	2008	Increment	Percent
<b>Total area in use (hectares)</b>	23,817,737	32,527,075	8,709,338	36.6%
Regi—n Oriental	11,428,750	13,782,464	2,353,714	20.6%
Chaco	12,388,987	18,744,612	6,355,625	51.3%
<b>Farms 500 has. and larger</b>	19,369,213	27,807,215	<b>8,438,002</b>	43.6%
Regi—n Oriental	7,544,169	9,763,716	2,219,547	29.4%
Chaco	11,825,045	18,043,500	6,218,455	52.6%
<b>Use of the land (has.)</b>				
<b>Cropland</b>	1,662,006	3,365,332	1,703,326	102.5%
Regi—n Oriental	1,616,288	3,342,080	<b>1,725,792</b>	106.8%
Chaco	45,818	23,252	-22,566	-49.3%
<b>Pasture</b>	12,571,895	17,685,620	5,113,725	40.7%
Regi—n Oriental	6,266,341	6,907,801	641,460	10.2%
Chaco	6,305,554	10,777,819	<b>4,472,265</b>	70.9%
<b>Forest</b>	7,818,423	9,107,867	1,289,444	16.5%
Regi—n Oriental	2,312,411	2,231,879	-80,532	-3.5%
Chaco	5,506,012	6,875,988	<b>1,369,976</b>	24.9%
<b>Other uses and fallow</b>	1,765,413	2,368,256	602,843	34.1%
Regi—n Oriental	1,233,710	1,300,704	66,994	5.4%
Chaco	531,603	1,067,553	535,950	100.8%
<b>Head of cows</b>	<b>1991</b>	<b>2008</b>	<b>Increment</b>	<b>Percent</b>
Total pa's	7,626,617	10,561,894	2,935,277	38.5%
Regi—n Oriental	5,237,892	6,690,002	1,452,110	27.7%
Chaco	2,388,725	3,871,892	<b>1,483,167</b>	62.1%
<b>Herds of 1000 head and larger</b>				
Total pa's	3,767,593	6,050,678	2,283,085	60.6%
Regi—n Oriental	2,158,574	3,358,035	1,199,461	55.6%
Chaco	1,609,019	2,692,643	1,083,624	67.3%
<b>Cropland in soybeans</b>				
Total pa's	552,657	2,463,510	1,910,853	345.8%

*see Statistical Annex for details*



### **III - Land Use Trends in Alto Paraguay and the Project Reference Area (Agua Dulce)**

The Department of Alto Paraguay was largely undeveloped through the end of the 1980s, except for extensive (low density) cattle ranching on natural pasture along the flood plain of the Paraguay River and the historical exploitation of quebracho wood (used for leather tanning) in the southern part of the Department.

Cattle ranching started to increase significantly during the 1990s in the interior of the Department, starting in the southwest corner closest to the Mennonite colonies in the central Chaco (Department of Boquerón), which were expanding their ranching operations into Alto Paraguay. Expansion continued northwards along a western corridor into the Agua Dulce area in the north of the Department, where soils are richer, rainfall more plentiful and land prices were lower. During the past 10 years, new ranches were established along a line eastward from Agua Dulce towards Bahia Negra.

See **Map 1** – Paraguay: Regions, Departments, annual rainfall and project reference area.

This development pattern (north from the central Chaco to Agua Dulce and then east towards Bahia Negra) was heavily influenced by the lack of direct road access from the Paraguay River. The ranches in the Agua Dulce area continue to use Filadelfia and Loma Plata in the central Chaco as their principal point of access to and from Asunción.

A second thrust of cattle ranching occurred in the southeastern portion of the Department between Puerto Casado (now Victoria) in the south and Fuerte Olimpo (the Departmental capital) about 150 kms to the north on the Paraguay River. This area borders the Brazilian state of Mato Grosso across the River, and Brazilian ranchers who have extended their operations into Alto Paraguay have heavily influenced development.

These three areas of cattle ranching – the southwest corner of Alto Paraguay, Agua Dulce and the southeast corner – can be seen on **Map 2**, which shows the “recommended” areas for agropecuario land use in the Northern Chaco.<sup>1</sup> The map shows five recommended areas, three of which are in Alto Paraguay (part of zone 1 and all of zones 4 and 5). These recommended areas took into account the existing land use through 2006, the existing national parks (not shown on this map), areas that are more appropriately destined for “natural tourism” (hunting and fishing), and areas where the land is not appropriate for agropecuario use.

At present, agropecuario land use in Alto Paraguay occupies 1.3 million hectares, about 16% of the Department’s total area of 8.2 million hectares -- See **Map 3**. Of the total area in use, 0.3 million hectares (288,476 has.) lie in the proposed REDD project reference area, Agua Dulce (described further below). The rest of the Department’s 6.9 million hectares (including 1.2 million hectares of national parks) remains largely unpopulated and undeveloped, especially in the northern and western sections, which contain large areas of dry, low scrub forest and sand dunes.

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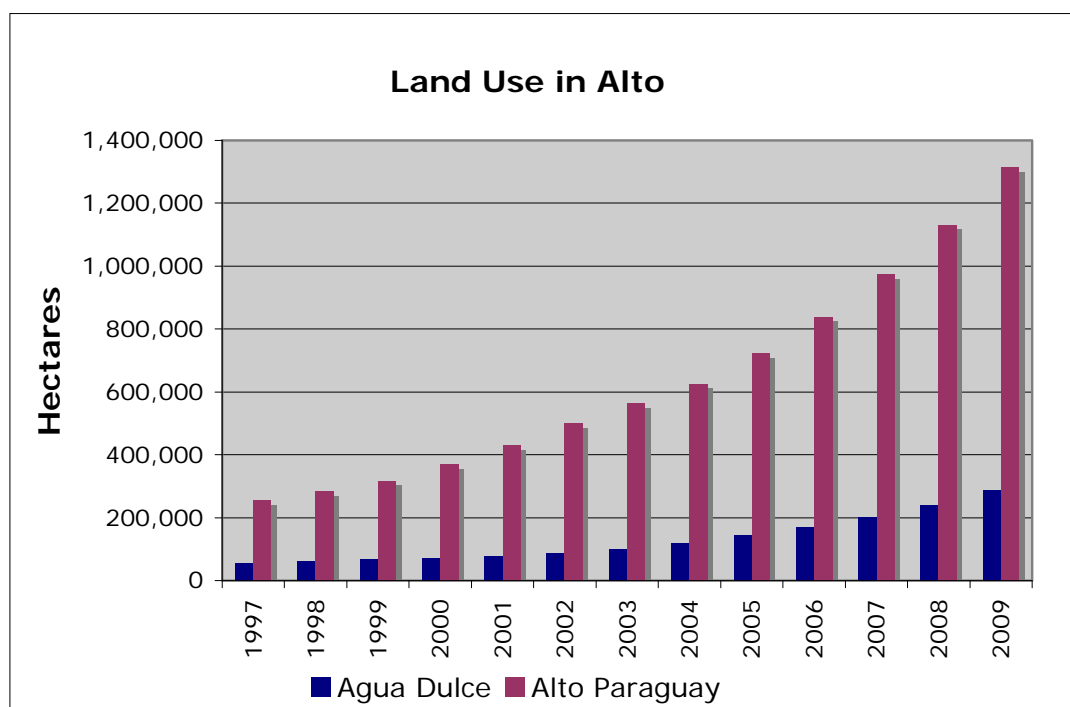
<sup>1</sup> SEAM, Proyecto Ordenamiento Ambiental del Territorio de los Departamentos Alto Paraguay y Boquerón, octubre de 2006.

During the past 12 years, from 1997 to 2009, agropecuario land use in Alto Paraguay increased by 15% per annum, expanding by a little over one million hectares. Notably, the rate of increase has been accelerating, especially in the Agua Dulce area where it reached 19% per annum in the last four years.

### Land Use in Alto Paraguay

Dept. Alto Paraguay				Reference Area REDD - Agua Dulce		
Total Area (has.)		8,234,900		Total Area (has.)		2,437,209
Agropecuario Usage	Period average growth rate	Increment (has.)		Agropecuario Usage	Period average growth rate	Increment (has.)
1997		256,981				56,224
2002	14.3%	500,693	243,712	85,975	8.9%	29,751
2005	12.9%	720,917	220,224	143,824	18.7%	57,849
2009	16.2%	1,315,476	594,559	288,476	19.0%	144,652
1997-2009		14.6%	1,058,495	14.6%		232,252
2009	Percent of total area in use		16.0%	Percent of total area in use		11.8%

Data based on satellite images. See Statistical Appendix (Annex 3) for details.



The economic factors driving this expansion include:

- the steady increase in world beef prices discussed earlier;
- the availability of cheap, good-quality land (see below);
- the availability of low cost labor for ranch hands (about \$100 per month);
- the virtual absence of invasions by landless peasants, compared to the Eastern Region where invasions are a common event. The Chaco region thus affords much greater security of private property; and
- little or no effective enforcement of environmental standards, which appears to have resulted in less forest reserve than legally required (discussed further below).

Land prices in the Agua Dulce area, for example, were previously \$25-40 per hectare in the 1990s, then rose to the \$100 range in the early 2000s, and are now in the \$150–200 range for land with high forest (*monte*), the presence of which is an indication of land suitable for conversion to high-quality pasture. On the other hand, due to a 25% minimum forest reserve requirement and other environmental norms (discussed below), ranchers need about two hectares of forest for every hectare to be cleared and converted to pasture. The cost of clearing forest, planting pastures and installing basic infrastructure (fencing, water tanks and distribution system, corral, sheds and staff buildings), about \$430 per hectare of pasture, must thus be added to the cost of land (see Annex 2, page 6, for details).

In total, the final cost of one hectare of high-quality pasture in the Agua Dulce area is currently about \$800, resulting from the purchase of two hectares of *monte* and the clearing and planting of one. These high quality pastures are capable of supporting one head of cattle per hectare, although the actual stock may be less for reasons noted in the preceding chapter.

Against the above mentioned drivers of land use expansion, there are several factors that have limited the expansion of ranching in Alto Paraguay, including:

- lack of infrastructure – there are no paved roads in Alto Paraguay, only dirt roads made of heavy clay soil, which turns soft and un-passable after heavy rain. Ranchers have to build their own roads when opening new areas, as well as pay the cost of road maintenance.
- Also, there are no ports suitable for shipping livestock downriver. Livestock for market is trucked out of the Department through the central Chaco. From Agua Dulce, the nearest meat processing plant is 300 kms. south in Loma Plata. If the supply of livestock exceeds this plant's capacity (500 head per day), cattle must be shipped another 420 kms. on paved road to Asunción, which implies additional cost and loss of weight.
- periodic drought and scarcity of water, which increases in intensity towards the west along the border with the neighboring Department of Boquerón. In this area, rainfall averages 800 to 900 millimeters per annum vs. 1200 mm along the Paraguay River.
- large areas of sandy soils that turn to sand when the scrub brush thereon is cleared. For this reason, ranchers look for high forest (*monte*) to clear for pasture, since the soils on high forest land are much richer, less sandy and can support implanted pastures of exotic grasses more suitable for commercial ranching than the natural grasslands of the Chaco.

- a limited availability of calves for raising. Ranchers buy calves from the central Chaco and then truck them into their ranches in Alto Paraguay for fattening.

Despite the above limitations and the cost of creating pastures, ranching in Alto Paraguay appears to be profitable at current world beef prices, as evidenced by its continued expansion. The financial returns to ranching in the Agua Dulce area are analyzed in chapter IV.

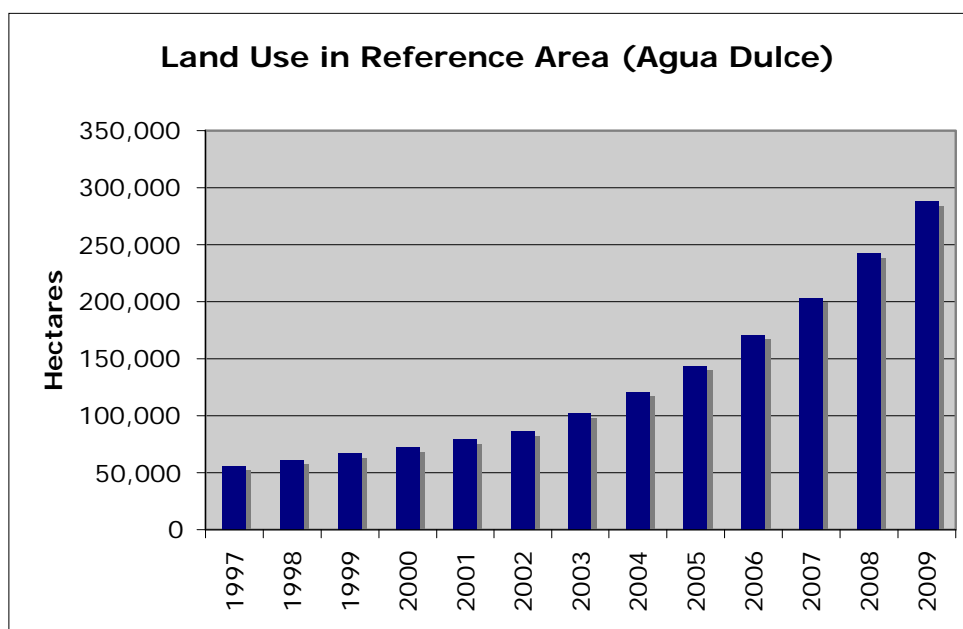
### Land Use in the Project Reference Area (Agua Dulce)

The REDD project reference area, Agua Dulce, comprises 2.4 million hectares in the northeast corner of Alto Paraguay. It was chosen and defined based on the following characteristics:

- it contains large areas of virgin forest that appear to be in the path of future land use change and deforestation;
- it is centered between three national parks and thus serves as corridor for preserving biological interchange among the parks;
- it is bounded by international boundaries on north and northeast with Bolivia (including the Rio Negro), and on the east with Brazil (a short stretch of the Rio Paraguay);
- on the south, it is bounded by a series of salty rivers and streams which form a natural barrier to the expansion of ranching;
- on the west, a straight line was drawn approximately along the 900 millimeter rainfall pattern, which seems to be a minimum level for the normal development of ranching. This line also intersects the national park Defensores del Chaco, with a significant area of the park (approximately 185,000 hectares) falling within the reference area.

These features can be seen on **Map 4 – Forests and Protected Areas in the Project Reference Area (Agua Dulce)**.

As mentioned, agropecuario land use in the reference area has been growing at an accelerating rate and currently occupies 288.476 hectares, as of May 2009.



The progression of land use change can be seen clearly on **Maps 5, 6, 7 and 8**, which are satellite images of the reference area for the years 1997, 2002, 2005 and 2009, respectively. Areas of agropecuario land use have been marked and measured using GIS techniques. These are the same areas that are shown in the table on page 18.

The cleared land has been used mainly for cattle ranching, which has grown in line with the change in land use. This can be seen from annual data on cattle vaccinations (see Annex 2 for sources and details). This data show a stable ratio of land to the number of cattle vaccinated, about 2 hectares per head in the last few years. This ratio is lower than for the Chaco as whole (2.8 hectares per head according to the 2008 Agricultural Census – see Chapter 2) and reflects the better quality of soils and the more extensive use of improved pastures in the Agua Dulce area.

<b>Cattle and Land Use - Agua Dulce</b>			
	<b>Land Use</b>	<b>Number of Cattle</b>	<b>Hectares</b>
	<b>(has.)</b>	<b>Vaccinated</b>	<b>per head</b>
2003	<i>102,060</i>	79,750	1.3
2004	<i>121,154</i>	55,727	2.2
2005	<b>143,824</b>	102,417	1.4
2006	<i>171,159</i>	114,413	1.5
2007	<i>203,690</i>	106,683	1.9
2008	<i>242,403</i>	128,181	1.9
2009	<b>288,476</b>	141,000	2.0

**Bold** - per satellite image; *italics* - interpolated

Nevertheless, the ratio of land to the number of cattle appears high vis-à-vis the reported carrying capacity of improved pasture in the Agua Dulce area – one unit weight (*unidad ganadera*) of livestock, equivalent to 400 kilos of live weight, per hectare (see Annex 2). This discrepancy may be attributable to ranchers taking advantage of the recent “fat” years of high beef prices and investing their excess cash flow first in expanding their ranches before fully stocking them. Also, due to the growth of beef exports and cattle ranching in general, there is a shortage of calves which may prevent as fast a buildup of the herd as would otherwise be wanted.

In addition to agropecuario use, there are several other features of land use in the REDD reference area. Three national parks fall within the area – Chavoreca in the north on the border with Bolivia with about 88,00 hectares, Rio Negro on the northeast with about 140,000 hectares divided into north and south sections, and part of Defensores del Chaco in the west with about 185,000 hectares inside the reference area.

In addition, a private reserve of about 62,000 hectares, Fortín Patria, lies between the north and south sections of Rio Negro national park and is in the process of establishing a permanent environmental easement for the transition of wildlife between the two sections. There are also about 51,000 hectares of restricted military zones and titled indigenous lands within the reference area.

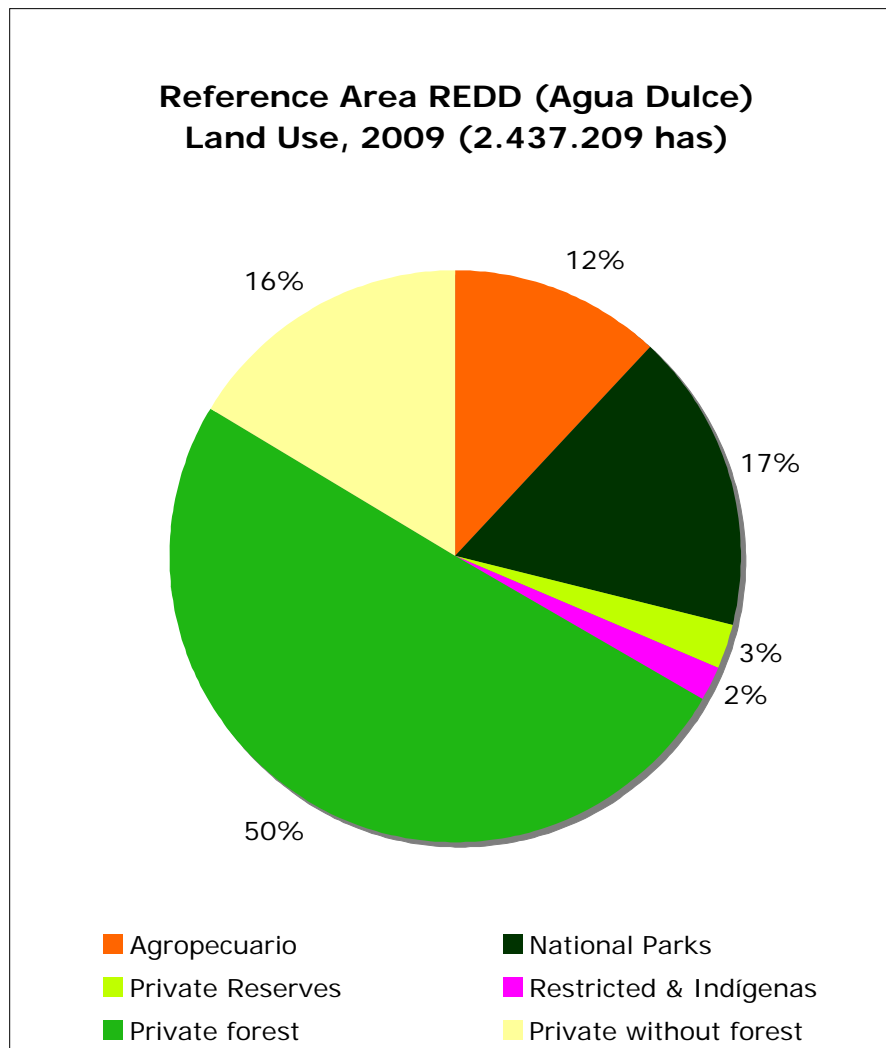
The remaining area, about 1.6 million hectares, is titled private land. This, of course, is in addition to the 288,000 hectares of private land already in agropecuario use. The remaining private land is estimated, based on satellite imagery, to be about three-quarters

forest (1.2 million hectares) and one-quarter non-forest (0.4 million hectares), including savannah palms, natural fields and low scrub land. The above statistics are summarized in the following table and graph.

#### Reference Area REDD (Agua Dulce)

##### Land Use, 2009 (has.)

Agropecuario	288,476	11.8%
National Parks	412,383	16.9%
Private Reserves	62,000	2.5%
Restricted & Ind'genas	51,553	2.1%
Private forest	1,220,732	50.1%
Private without forest	402,065	16.5%
<b>Total area</b>	<b>2,437,209</b>	<b>100.0%</b>



#### Environmental Requirements and Considerations

There are two main environmental requirements that affect the clearing of forest in Paraguay:

- i. Law 422 of 1973, which requires the maintenance of a 25% forest reserve in all agricultural establishments and the protection of streams with a 100-meter wide strip of forest. This law applies to the entire country, although it has been widely circumvented,<sup>2</sup> especially prior to the creation of the Secretariat of the Environment (SEAM) in 1999, which is in charge of approving licenses for land use change and monitoring compliance.<sup>3 4 5</sup>
- ii. Presidential Decree No. 18.831 of 1986, which limits the size of a single pasture to a maximum of 100 hectares and requires a minimum 100 meter wide strip of forest (*cortina de viento*) to be maintained on all sides of the pasture as a measure to prevent wind erosion. This requirement does not prevent, however, the combination of many pastures of 100 hectares each in one large area, as long as the required forest strip separates each pasture, which is what has occurred in practice. Note that the requirement to maintain forest as windbreaks is in addition to the requirements for the 25% forest reserve and for protecting water sources.

Regarding compliance with the 25% reserve requirement, it is evident from the satellite images of older clearings, e.g., the southwest corner of Alto Paraguay – see Map 3, that the required forest reserve has not been maintained. In this area, several large continuous swaths of pasture / fields have been created, some up to 30 kms. on each side, and it is not clear where the 25% forest reserve could be.

Compliance is less clear with newer clearings, in particular, in the project reference area. The progression of satellite images from 1997 to 2009 (Maps 5 – 8) show several large areas of pasture that were extended in a similar continuous manner as in the southwest corner of Alto Paraguay, and compliance with the reserve requirement is therefore questionable.

Nevertheless, there remains sufficient un-cleared forest next to or near most properties in the Agua Dulce area to allow for the possibility of at least partial compliance. Indeed, some projects claim to have respected the requirement completely and maintain the required 25% reserve alongside a series of cleared pastures, each with the required windbreaks (see information from Cooperative Fernheim in Annex 2).

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<sup>2</sup> For example, after clearing forest on the permitted 75% of land, part or all of the forest reserve is subsequently sold to another person who applies for permission to clear 75% of the new smaller property;

<sup>3</sup> The reserve requirement was raised to 40% in May 2009 (SEAM Resolution 1616/ 09), but the increase was subsequently voided in July 2009 on the grounds that a resolution cannot modify a law (Law 422).

<sup>4</sup> At the same time, in May 2009, SEAM suspended the granting of new licenses for forest clearing in the Chaco, but this decision was also revoked in July.

<sup>5</sup> Finally, it should be noted that a Law of Zero Deforestation has been in effect for the Eastern Region since 2006. It has been debated whether to extend this law to cover the Chaco, but at present, this does not seem to be a likely development.

With regard to the windbreak requirement, compliance appears to be much more complete, if only for reasons of self-interest to minimize the soil erosion caused by strong winds that blow most days from the north during the dry winter months (July through September).

The preservation of forest in the form of windbreaks is a recent practice, however. As can be seen from a careful inspection of the satellite images, windbreaks were not incorporated in most of the early clearings in the Agua Dulce area – see clearings in the lower center of Map 5 (1997), a detail of which is provided in **Map 9** – pasture without windbreaks.

In contrast, most if not all clearings since then have maintained forest in the form of windbreaks. See Map 8 (2009), a detail of which is provided in **Map 10** – pastures with windbreaks.

The most prevalent practice appears to be to clear forest in sections of 2,000 x 500 meters (resulting in pastures of 100 hectares), leaving the required 100 meters of forest on each side. In this format, 25 hectares of forest for windbreaks are required for each pasture of 100 hectares. Some ranchers nevertheless prefer to leave a strip 200 meters wide along some sides, which increases the residual forest accordingly.

While the incorporation of natural forest as windbreaks implies additional cost in terms of purchase of land, it also brings economic advantages. The pastures are configured to provide cattle with access to the windbreaks, when permitted, to seek supplemental forage and warmth in the winter and shade in the summer. The windbreaks, while still technically forest,<sup>6</sup> are nevertheless part of the silvo-pastoral system of ranching and are likely to degrade over time as foraging progressively depletes the underbrush vegetation and compacts the soils. For this reason, they cannot be considered to maintain the same characteristics as the original forest in the 25% reserve areas.

In general, a new culture of environmental awareness and self-interested compliance appears to have emerged in recent years in the Agua Dulce area, even if not yet adopted by all new commercial ranchers. As a result, new ranching projects are maintaining up to 45% of the forest on their land – 25% for forest reserve, 15% for windbreaks and 5% for protection of streams and water sources, depending on their location.

Finally, the SEAM recently issued regulations for Law 3001 of 2006 on Environmental Services which permits owners of “excess” forest, namely lands with more than the required 25% reserve, to sell rights to the excess in the form of environmental services to landowners with less than the required reserve. Once the market for such services develops, this will provide an alternative to deforestation for those who wish to gain income from their “excess” forests, as well as a mechanism for those with less than the required 25% reserve to bring their properties into compliance.

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<sup>6</sup> SEAM defines “forest” as land of at least 2 hectares with at least 60 mature trees per hectare with trunks of at least 15 cm in diameter (at chest level) whose tops cover at least 50% of the land area.



## IV - Projected Changes in Land Use in Project Reference Area

In view of the almost exclusive dedication of land to cattle ranching in the project reference area, future changes in land use will be driven principally by the price of beef. The trends in world beef prices and export values for Paraguayan beef were analyzed in Chapter I. Basically, they have followed similar long-term trends towards the upside driven by expanding world demand and rising incomes in emerging countries where incremental income is devoted in large part to improving diets, in particular, animal protein.

The following table summarizes the market price of live cattle in the Asunción market, which is the reference price for ranchers in Paraguay. The difference between the live cattle market price and the realized export price (which was about \$2.50 per kilo in 2006/07, rising to \$3.50 in 2008) represents the gross margin of the meat processing plants and the fact that export prices are for the choicer cuts of meat. The relationship between the two is therefore not exact. Nevertheless, the live cattle price in 2008 rose by about the same one-third as the export price and world beef prices.

### Average Prices per kilo for Live Cattle, Asunción

Period	Guaranies	US cents	Exch. rate
2006, I	4124	70	5877
2006, II	4680	86	5421
2007, I	4385	86	5119
2007, II	5263	107	4942
2008, I	5742	131	4202
2008, II	5837	135	4324
Dec-08	5154	105	4909
Jul-09	5330	107	5000

*Source: SENACSA, see statistical appendix page 6 and El Corral S.A. for July 2009*

Market prices for beef have, of course, fallen off their 2008 peak back to the level of 2007, and have remained stable at that level for the first half of 2009. While it is beyond the scope of this paper to project future world and local beef prices, the current price and exchange rate appear to provide a reasonable basis for analyzing the financial returns to cattle ranching in Paraguay.

### **Financial Returns to Ranching in the Project Reference Area**

A financial model of ranching in the project reference area was constructed based on parameters discussed in Annex 2. To summarize, a new ranch is assumed to be created on a standard size lot of 4,000 hectares of privately owned forest, which, as noted in the previous chapter, represents about one-half of the land in the project reference area. It is assumed that land is purchased for \$175 per hectare, about average for the area at present.

Forest cover is cleared in accord with existing environmental norms, e.g., leaving 25% forest reserve, protecting water sources and leaving windbreaks of 100 meters wide around all new pastures. This permits clearance of 2,200 hectares on which high-yield pastures are planted and all necessary infrastructure is installed (fencing, water tanks, water

distribution systems, corrals, basic housing for staff, etc.), all at a cost of \$435 per hectare of cleared pasture. Total investment in land purchase, forest clearing and infrastructure is about \$1.7 million for each lot of 4,000 hectares. (New ranches are usually a multiple of such lots and should benefit from economies of scale.)

Calves for fattening are purchased in the central Chaco and trucked into the area for a one year fattening cycle that aims for weight gain of 200 kilos per animal. Stocking is in accord with the carrying capacity of implanted pastures for the area, namely, 1.2 calves per hectare. The “finished” cattle are trucked back to the central Chaco for slaughter and are sold at the current Asunción market price for live cattle, \$1.05 per kilo. (This price is also used for the purchase of calves.)

The returns to this model are summarized in the following table. The base case return to investment is estimated at 15% per annum over 10 years. Extending the investment horizon to 15 years increases the internal rate of return to 18%. If the ranch were sold at the end of this period for the same price as the initial investment, namely without any gains due to rising land prices, the IRR including the return of capital increases to 20% per annum.

#### **Financial Returns to Investment in Cattle Ranching - Zona Agua Dulce**

Ranch model of 4000 hectares (standard lot)

<b>Key Parameters</b>	<b>Base Case</b>	<b>Beef @ \$1.10</b>	<b>Land @ \$200</b>	<b>Lower Stock</b>	<b>Sale @ 420 kgs</b>	<b>Conservative</b>
price of land (monte), \$ per hectare	175	175	<b>200</b>	175	175	175
beef reference price, \$ per kg	1.05	<b>1.10</b>	1.05	1.05	1.05	<b>0.95</b>
weight at sale, kg. per head	440	440	440	440	<b>420</b>	<b>420</b>
stocking ratio, head per ha.	1.2	1.2	1.2	<b>1.1</b>	1.2	1.2
<b>Internal Rate of Return - 10 year</b>	<b>15%</b>	<b>17%</b>	<b>13%</b>	<b>13%</b>	<b>10%</b>	<b>6%</b>
<b>Internal Rate of Return - 15 year</b>	<b>18%</b>	<b>20%</b>	<b>17%</b>	<b>16%</b>	<b>14%</b>	<b>11%</b>
<b>IRR - 15 year, w/ return of capita</b>	<b>20%</b>	<b>22%</b>	<b>19%</b>	<b>18%</b>	<b>17%</b>	<b>14%</b>

*See Annex 2, page 9 for details*

The above base case returns are indeed attractive and explain the rapid and accelerating pace of deforestation in the project reference area against the backdrop of rising world beef prices. The above returns are also quite robust to changes in the basic parameters of the model.

The most sensitive parameter is the price of beef. An increase of US 5 cents in the market price of live cattle in Asunción to \$1.10 increases the IRR by 2 percentage points per annum, to 17% for a 10-year investment horizon. Additional US 5 cent increases add an additional 2 percentage points to the IRR for each increase. This sensitivity is very powerful, but, of course, operates both ways -- a US 5 cent decrease in the beef price would reduce the IRR to 13% for a 10-year investment horizon (not shown in the above table).

Other downside events would similarly reduce the IRR, but not to unacceptable levels. For example, if new ranches had to pay \$200 per hectare for forestland instead of \$175 assumed in the base case, the 10-year IRR would fall to 13%. Or if the availability of calves for fattening were limited over the life of the project to permit only 1.1 head per hectare instead of 1.2, the IRR would similarly fall to 13%. A more severe impact would

occur if the cattle gain only 180 kilos per year, instead of 200 kilos, and were thus sold with a finished weight of 420 kilos instead of the 440 kilos assumed in the base case. In this event, the 10-year IRR falls to 10%.

A final conservative scenario is for the price of beef to average only US 95 cents over the life of the investment (10% less than at present) and for the weight gain to average only 180 kilos per head per year. In this event, the 10-year IRR falls to 6%, but with a 15-year time horizon, including the return of capital, it would still yield a respectable 14%.

In sum, longer time horizons and the recapture of initial investment costs, which is highly likely given the long history of appreciation in land prices, provide a firm comfort level for investment in ranching.

An alternative way to view the impact of beef prices is to consider how much ranchers would be willing to pay for additional forest to create new ranches at different beef prices, while expecting to receive a 15% rate of return for 10 years. The following table presents this approach, which perhaps best demonstrates the forces that have pushed up land prices in the project reference area over the past decade.

The table shows that if beef prices for live cattle in Asunción increased by US 10 cents per kilo from their present level to \$1.15, and were viewed to remain at this level into the future, ranchers would be willing to pay up to \$240 per hectare for forest in the Agua Dulce area and could still expect a 15% rate of return. Given that the Asunción beef price averaged \$1.33 in 2008, such a scenario is very possible. If the 2008 price were viewed to be permanent, land prices of \$370 per hectare for forest would be justified.

**Implied Land Prices (Agua Dulce) at various Beef Prices  
with 15 Percent Rate of Return (10 years)**

<b>Live Cattle Price, ASU</b> (US cents per kilo)	<b>Implied Land Price</b> (US\$ per hectare)
95	110
105	175
115	240
125	305
135	370
150	470

In sum, current economic conditions (namely, current beef prices, land prices and the technical parameters of ranching) provide an attractive return for investment in new cattle ranches in the Agua Dulce area. This implies continuation of deforestation for the foreseeable future. Significantly higher beef prices would likely accelerate the rate of deforestation and lead to higher land prices for the remaining forest.

### **Economically Useful Zones within Project Reference Area**

The project reference area described in the preceding chapter comprises 2.4 million hectares, of which only about 0.3 million hectares are currently in use. Not all of the rest is available for agropecuario use, however. As previously discussed, the reference area

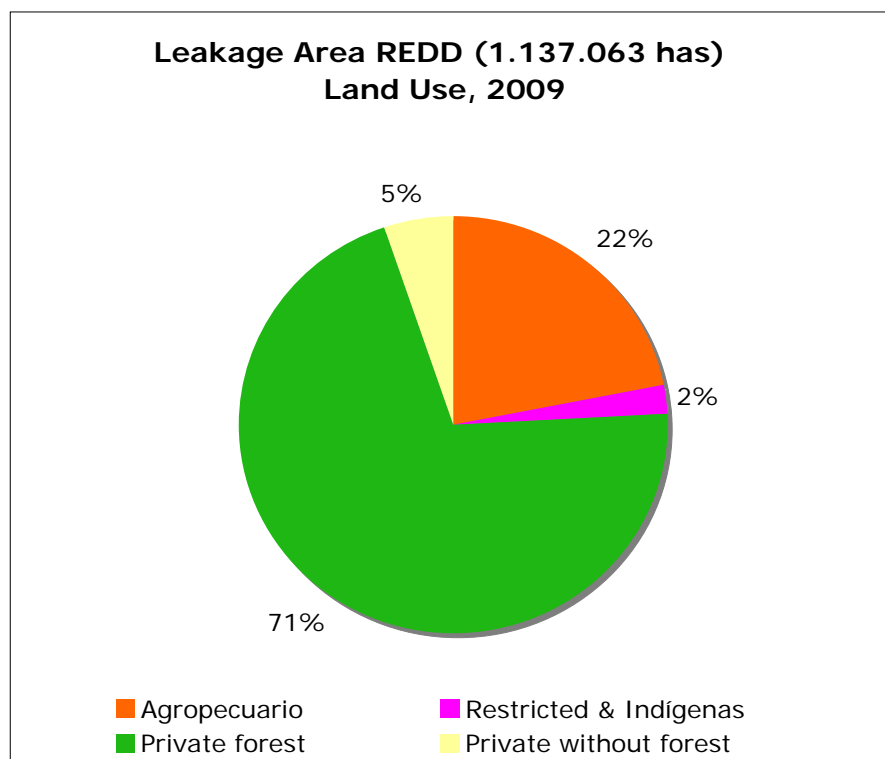
includes large areas of national parks and private reserves (over 0.5 million hectares) and considerable non-forested areas (0.4 million hectares). Also, not all of the forested area is of the type suitable for conversion to improved pasture. Much of it is low-level scrub on sandy soils.

For purposes of assessing the potential for future land use change, a reduced area of 1.137 million hectares has been identified that excludes the above protected and less desirable areas. The reduced area, henceforth referred to as the project “leakage” area, is based on the “recommended” area for agropecuario use identified by the SEAM in 2006 (see map 2). This area has been slightly amplified to include some out-lying areas that have the types of forest that ranchers view as desirable for conversion to pasture due to their soil qualities, namely, xerofito and mesoxerofito forest.

The project leakage area is shown in **Map 11** -- the area within the heavy red line. The map also shows actual agropecuario use within this area, and existing indigenous and restricted (military) areas. The rest is mostly privately owned forest of the xerofito and mesoxerofito types (about 800,000 hectares) and a small amount of un-forested area. These areas are summarized in the following table and chart.

**Leakage Area REDD (Agua Dulce)**  
**Land Use, 2009 (has.)**

Agropecuario	250,578	22.0%
Restricted & Ind’genas	25,123	2.2%
Private forest	801,921	70.5%
Private without forest	59,441	5.2%
<b>Total area</b>	<b>1,137,063</b>	<b>100.0%</b>



The area is referred to as a “leakage” area because the conservation of any forest within this area would prevent alternative agropecuario use on the conserved property and displace it to another area of forest within the leakage zone, but not likely beyond the leakage area due to the poorer quality of soils and forest outside the area. Future deforestation would thus “leak” within the area, but not outside it.

As indicated above, the leakage area has about 800,000 hectares of standing good quality forest. Not all of this forest is available for conversion to pasture, however, because the standing forest should in principle include the 25% forest reserve for the land already in agropecuario use. The satellite imagery used to measure land currently in use captures the pastures and the intervening windbreaks, but has no way of separately identifying the required forest reserves from the adjoining forest.

The estimates of future deforestation developed below must therefore assume that the required reserves for existing ranches exist, or will be purchased under the recent Environmental Services law to comply with the requirement. Such reserves are thus deducted from the area of remaining forest to derive the area available for new ranches. All future land use change must, of course, also set aside the required 25% forest reserve. The net amount of forest thus available for conversion to pasture, including windbreaks and therefore conceptually equivalent to the satellite measurements of existing agropecuario use, is thus considerably less than the 800,000 hectares of forest remaining in the leakage area.

These considerations are set out in the table below, which estimates total possible deforestation in the leakage area at 554,000 hectares. If all this area were eventually deforested, total agropecuario land use in the leakage area would rise to 805,000 hectares, equivalent to 71% of the total 1.137 million hectares in the area.

<b>Leakage Area REDD - Agua Dulce</b>	
<b>Forest Areas Available for Conversion to Pasture (has.)</b>	
Private forests apt for conversion to pasture	801,921
less, 25% forest reserves associated with lands currently in use (250,578 has.)	62,645
Net forests available for new ranches	739,277
less, 25% forest reserve on new ranches	184,819
<b>Possible net new deforestation</b>	<b>554,457</b>
Memo: Eventual total possible area in agropecuario use (existing 250,578 plus new 554,457)	805,035

How fast and in which areas such deforestation is likely to occur is analyzed below.

The following table sets out a range of deforestation outcomes based on mathematical criteria to illustrate how fast or slow complete utilization of the leakage area could occur. (The factors underlying a possible base case, low case and high case scenario are discussed further below.)

If deforestation continues at the average rate of the past seven years, namely 19% per annum compounded, the leakage area would be completely utilized by 2016, with only the required 25% forest reserve remaining. Even at a much slower compound rate of 10% per annum, all possible forest would be converted to agropecuario use by 2022. A similar outcome would occur if deforestation proceeds at a constant absolute amount of hectares per annum (46,000 -- the same as from 2008 to 2009), with complete utilization occurring by 2021. This constant pace actually implies a decelerating rate, as the numerator stays constant while the base grows larger each year.

An 8% growth rate, equivalent to a constant 36,000-hectare absolute amount of deforestation (the average for 2005-09) postpones complete utilization by only three years to 2024-25. Only a 5% growth rate postpones complete utilization beyond a 20-year time frame.

#### **Range of Deforestation Outcomes in Leakage Area REDD (Agua Dulce)**

<b><u>Growth Rate</u></b>	<b><u>Year in which Agropecuario Use Reaches 100% of Available Useful Area (805,000 hectares)</u></b>	
2002-2009 average (19%)		2016
1997-2009 average (14.5%)		2018
10 Percent		2022
8 Percent		2025
5 Percent		2033
<b><u>Constant Increase in Hectares per annum</u></b>		
at Rate of		
2009	46073	2021
2005-09 av.	36163	2024
2005	19283	2038

*See annex 3 (Statistical Appendix), table 11*

Deforestation is unlikely to proceed at a constant rate or at constant absolute amount of hectares. Nevertheless, it is likely to proceed at some average rate within the above range, and nearly all of the outcomes result in the complete utilization of the leakage area within a 20-year time frame.

#### **Base case**

In a base case scenario, it could be expected that the price of beef would continue to rise gradually in real terms over the next decade, as it has since the mid-1990s, reflecting

increased world demand for animal protein. This would continue the pressure for expansion of ranching and drive up land prices accordingly.

In the base case, existing environmental laws in Paraguay remain the same, thus permitting the continued issuance of licenses for deforestation in Alto Paraguay (with the required 25% forest reserve, forest barriers as windbreaks and protection of water sources).

Ranching in the Agua Dulce area has now reached a critical mass, with the presence of each additional ranch reinforcing the drive for further expansion and improvement of infrastructure, roads in particular. At some point during the next five years, it is likely that the main access road from the central Chaco into the Agua Dulce area and from Agua Dulce to Bahia Negra will be paved. This will accelerate deforestation under the base case.

Under this base case scenario, the recent rate of deforestation (15–19% per annum) could well be maintained for the next few years until the most accessible areas are fully exploited. It might then slow down somewhat with less choice of forest to exploit and as further expansion moves into the more remote areas.

In sum, even with fluctuations in the price of beef that would speed up or slow down the pace of establishing new ranches, the factors associated with a base case scenario point to complete utilization of the leakage area by the early 2020s, or by 2025 at the latest.

### **Low case**

A low case scenario would be characterized by sharply lower beef prices over the period, e.g., US 75 cents per kilo live weight in Asunción. It would take a few years for lower prices to stall actual deforestation, however, as there are a number of plans for land use change that have already been approved and these projects would likely go forward so as not to face expiration of the two-year license for implementing the approved land clearing.

Political factors could also slow the approval of new land use licenses if the Government turns more anti-investment or just attempts to slow down deforestation by dragging out the license approval process in the absence of a zero deforestation law for the Chaco (see previous chapter).

Other important low case factors are the occurrence of drought more frequently than normal (about three years out of ten) and the reappearance of foot and mouth disease. Concerning the latter, ranchers in Paraguay have established a very strong record in vaccinating against the disease, which has not appeared during the past five years.

Some combination of the above low case factors would likely delay complete utilization of the leakage area to about 2030. It should nevertheless be noted that land use change began in the Agua Dulce area in the 1990s, when live cattle prices were much lower than today (as were land prices), when foot and mouth disease reoccurred periodically, and when Paraguay had much less access to the international meat market than it now has. The driving factors were nevertheless sufficient to risk new ranching operations in an untried area. The same forces may thus push for faster land use change than indicated in spite of the occurrence of low case factors.

## High case

Sharply higher beef prices, e.g., \$1.25 and higher, would likely maintain or even accelerate the recent rate of deforestation in the leakage area. Under this scenario, available forest could be completely occupied by 2016.

In addition to the paving of the main road into and through the Agua Dulce area, which is likely under the base case, there are two important infrastructure projects under consideration that would influence future ranching development in central and northern Alto Paraguay. The first is a bridge from Carmelo Peralta, which lies on the Paraguay River in the center of the Department, to Puerto Murtihno in Mato Grosso, Brazil. The Brazilian Government has indicated its intention to finance this bridge, which would provide direct access to the Brazilian meat market and greatly increase ranching activity in the center of Alto Paraguay (in which Brazilian ranchers are heavily involved). Such development and market access would have stimulative spillover effects on ranching in the leakage area.

The second project is the building of a long-awaited water pipeline from the Paraguay River to the central Chaco. Provision of a secure and voluminous source of water to the central Chaco would facilitate, among many other economic activities, the raising of more calves for fattening – a periodic constraint on ranching in Paraguay, including in the leakage area – and the establishment of a second meat processing plant. This would benefit the leakage area by creating a larger market for live cattle in the central Chaco and avoid the cost of transport to Asunción. Financing for the proposed water pipeline has not yet been secured, but the pressure builds each year and it is likely that it will eventually happen.

The realization of either of these infrastructure projects would accelerate ranching development in the leakage area push the outcome towards a high case scenario.

Finally there is a third, but less studied infrastructure project that could considerably change the economics of land use in the eastern section of the leakage area. This is the building of a port for shipping soybeans and possibly live cattle down river from Bahia Negra. Soybeans have reportedly been successfully tested in the leakage area. So far it has served for supplemental feed for cattle, along with limited quantities of sugar cane and sorghum. Long distances make it uneconomic to ship out by truck, but a port on the River could change the outlook and have major implications for land use in the area.

The possibility of building a port in Puerto Ramos (just south of Bahia Negra) has reportedly been considered by private investors. A property in this area is also an alternative for the REDD project and is discussed in the last section of this chapter.

## Likely direction of future deforestation

There are two sub-zones where deforestation is likely to concentrate in the near term. Both of these areas have relatively good access to roads and high quality forest:

- i. the northwest corner of the leakage area where a significant network of secondary roads has already been created; and
- ii. the eastern area of the polygon adjacent to the Rio Negro Reserve, where the forest quality is highest.



These two zones are shown on **Map 12 – Zones of Probable Deforestation in the Near Term**. A third possible area is the central corridor from Agua Dulce to Bahia Negra between the two main roads that run west to east. However, this area may contain many of the required forest reserves of the properties already in use, and the availability of forest in this central corridor for additional land use change is in question.

### **Summary of projected land use change in the leakage area**

Deforestation in the leakage area is likely to continue at a high rate for the foreseeable future and all available land is likely to be utilized within the next 20 years. A high probability exists that this will occur by the early 2020s (base case scenario). There is also a reasonable probability that land use change will be complete earlier than 2020 (high case scenario). The possibility of a longer transition period extending to 2030 exists (low case scenario), but the probability of this is low, perhaps less than 10%.

### **Addendum on Bahia Negra Reference Area and Puerto Ramos Property**

In addition to the leakage area discussed above, there is a small area of forest just east and south of the town of Bahia Negra on the Paraguay River that could be attractive for land use change, either for cattle ranching or perhaps soybean cultivation. This area lies about 25 kms. southeast of the eastern tip of the leakage area and is separated from the same by a small river that runs into the Paraguay and by broad swath of palm trees subject to seasonal flooding. The area itself is on high ground, however, and the forest cover consists of mature quebracho and other hardwood trees that indicate the desirability of soils suitable for agriculture and / or improved pastures.

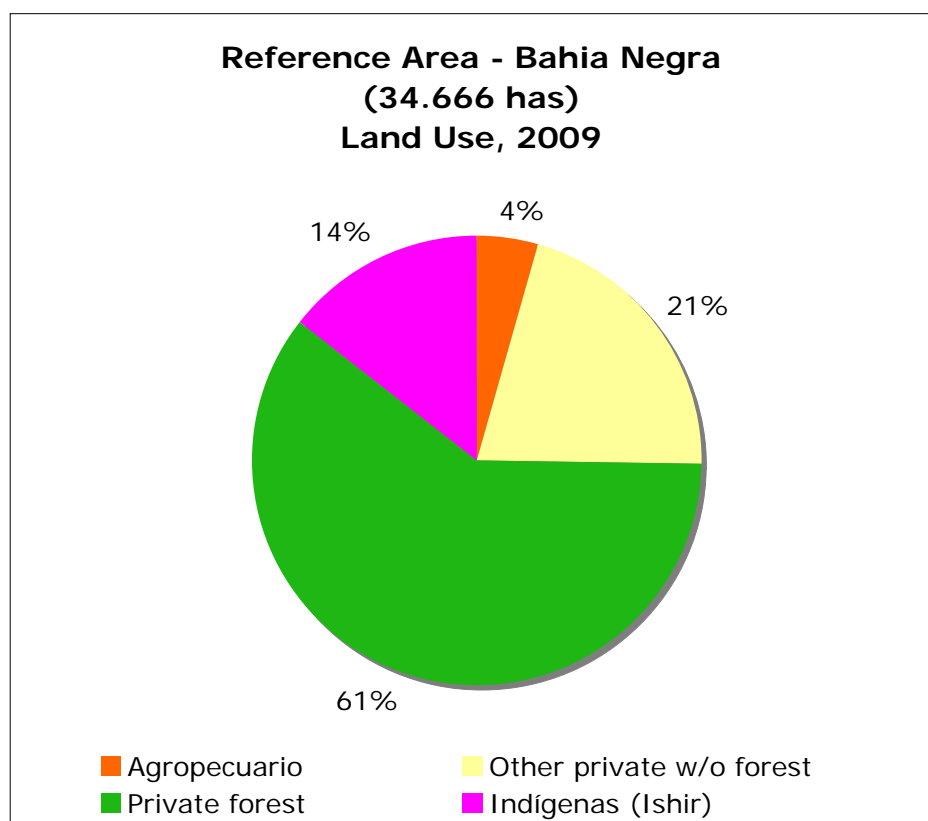
The area, henceforth referred to as the Bahia Negra reference area, is shown in **Map 13**. It consists of 34,666 hectares, of which only about 1,500 have been cleared for agropecuario use. Two-thirds of the clearing occurred prior to 1997, however, and since then, less than 50 hectares per year have been cleared.

While the soils of the area may be desirable, the Bahia Negra area as a whole is the furthest removed from the central Chaco. Also, due to very heavy rainfall in the area (1200 millimeters per annum), the first 50-70 kms of roads west from Bahia Negra into the interior of the department are useable only about three months a year. The area is thus very isolated despite being on the Paraguay River, which explains the slow pace of deforestation.

The Bahia Negra reference area is mainly privately owned (85%), while two indigenous properties occupy about 15% of the area. Forest is estimated to occupy about 25,300 hectares (73% of the total area), including about 4,500 hectares of forest on the indigenous areas. The private areas without forest consist of floodable areas mostly along the Paraguay River and to some extent along the course of the small river to the west of the reference area. The ownership and use of the area are shown in the graph and chart on the following page.

**Reference Area - Bahia Negra**  
**Land Use, 2009 (has.)**

Agropecuario	1,499	4.3%
Other private w/o forest	7,307	21.1%
Private forest	20,836	60.1%
Ind'genas (Ishir)	5,024	14.5%
<b>Total area</b>	<b>34,666</b>	<b>100.0%</b>



Aside from possible agropecuario use, the area is potentially attractive as a port. Reportedly, there are sections along the Paraguay River with high banks (e.g., 15 meters high) that would be suitable for building docks. The commercial utility of a port would require, however, a major improvement in transportation access from the interior of the Department, for example the paving of the road from Agua Dulce to Bahia Negra (a possibility mentioned under the base case).

The existence of a paved road into Bahia Negra and a port would significantly alter the economics of both ranching and agriculture in northern Alto Paraguay. Live cattle could be shipped downriver to Puerto Murtihno in Brazil (see previous discussion of a probable bridge linking Alto Paraguay with Brazil), or to Concepción in Paraguay with much less weight loss than occurs with the current situation of trucking them into the central Chaco. Also, ranches could opt for a mixed production model of cattle and crops to spread their risks

over several products. As mentioned, soybean, sugarcane and sorghum have reportedly been successfully tested in the leakage area.

If such a port were to materialize, parts of the existing forest would certainly be use to accommodate the related commercial facilities, such as holding yards, grain silos and receiving areas. More importantly from a land use change perspective, existing forest would likely be converted to agropecuario use to take advantage of the next-door location to the new transport facilities.

In the above context, one property in the reference area stands out as a possible site for a port. This is the “Puerto Ramos” property, which consists of 8,700 hectares, of which 6,100 are forested – see **Map 14**. It should be noted that deforestation on this property would affect the indigenous peoples in the two neighboring properties that border Puerto Ramos on the north and the south. Until now the Ishir have transited to and from their own lands through the Puerto Ramos property. For this reason, in addition to the carbon content of the forest on this property, it is being considered as a site for the REDD project.

End of main text.

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