ECUADOR

The Government of Ecuador has adopted policies intended to promote the development of a national biofuels industry, but with the express condition that it does not impact food supplies. The country has two historical agricultural production systems that will form the foundation for a modern biofuels industry: sugar cane and oil palm. The short term goal of the Ecuadorian government is to replace 10% of current gasoline consumption with alcohol blends and, simultaneously, to end the current practice of importing anhydrous ethanol for use as a fuel supplement. The national goal for biodiesel consumption is even more ambitious, with a 20% consumption target for of biodiesel. In neither case, however, has a clearly identified date or strategy been defined for meeting these targets.

Ecuador has approximately 70,000 ha of sugar cane fields and produces about 453,000 million tons of sugar per year contributing about 1.4% to national GDP. More than 80% of the sugar cane growers have farms smaller than 80 ha and only 5% farm more than 200 ha; growers are organized into a national union of sugar cane growers (UNCE according to its Spanish acronym). All three are located in the Guayas and Cañar Province on the southern coastal plain near the city of Guayaquil, an area characterized by a seasonally humid climate. Apparently, 90% of the sugar cane fields have irrigation systems, which is probably a response to historical events where national production was severely impacted by periodic droughts associated with El Niño. There are six sugar mills in Ecuador, but the three largest enterprises produce 90% of national production (San Carlos, Troncal, and Valdez).[1] Apparently, these mills have installed thermoelectric facilities that use bagasse to generate electricity for the national grid, but none apparently distills anhydrous ethanol as a biofuel. In 2006, the Brazilian government agreed to finance a US$100-million initiative to set up two ethanol plants and to introduce high-yielding varieties of Brazilian sugar cane. However, regulatory impasses and market uncertainties have impeded implementation of the distilleries.

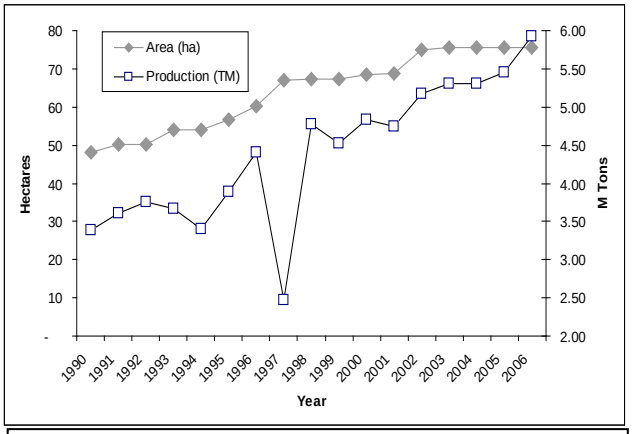

Figure 1. Sugar Cane production in Ecuador: The area under cultivation has increased by about 32% over the last 15 years; the impact from the El Niño event of 1997 on yields prompted most producers to invest in

Ecuador has been producing palm oil for more than 50 years for both its domestic consumption of vegetable oil, as well as for export. Oil palm plantations are located in eleven of its 22 provinces, including both the humid northeastern coastal plain and the Amazon lowlands. Nonetheless, three provinces account for approximately 85% of total national production: Esmeraldas, Pichinchi, and Los Ríos (see map). According to government statistics, there are more than 5600 separate production units that cultivate a total of ~207,000 hectares: ~30% are located in industrial plantations, ~32% in medium sized farms and ~38% in small holder plots (without defining what is considered small or medium).[2] Apparently, there are numerous extraction facilities (35?) that process fruit bunches, but there are only four processing facilities that transform crude palm into a refined vegetable oil (La Fabril, Danec, Ales and Epacem).[3] The largest of the Ecuadorian firms (La Fabril) made headlines in 2006 when it imported more than 10 million gallons

(~35 million tons) of biodiesel to the US market and announced plans to expand capacity to 36 million gallons per year.[4] However, the largest destination for Ecuadorian exports of vegetable oil is Venezuela, which imported about 57,000 tons worth about $43 Million dollars in 2007.[5]

The impact of these two crops on land-use and land-use change is proportional to the total area under cultivation and the rate of expansion that both sectors have experienced over the last two years. For example, oil palm plantations have increased by about 200% over the last decade, while sugar cane plantations have increased only about 30% over the same period. However, even more important is the impact of these two crops is the source of the land that is used for expansion. Sugarcane is cultivated on landscapes in an area that were converted in historical periods, while the northwest province of Ecuador has experienced significant deforestation over the past decade. Although data from remote sensing instruments is limited by high cloud cover, this region is well known to be one of the most conflictive zones in Ecuador and, allegedly, more than 45,000 hectares of forest land have been cleared in Esmeraldas province since 1999 and allegations that this expansion has occurred in violation of a variety of land-use and forest management regulations and laws. In the Amazon, where better remote sensing data is available, the expansion of oil palm plantations is directly responsible for the deforestation of xxx.xxx hectares of tropical forest vegetation between 1990 and 2000 (See Figure X).

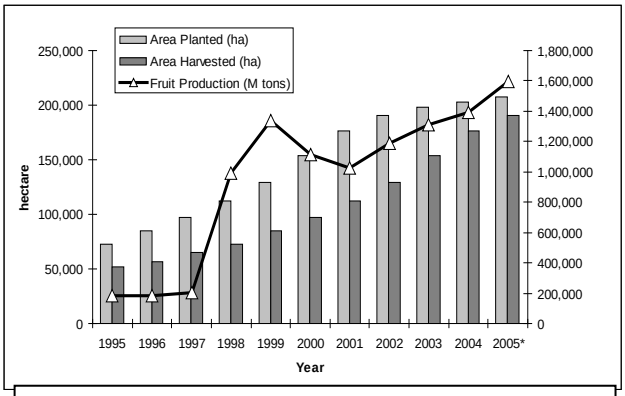

Figure 2. Official statistics for oil palm production in Ecuador; data from the mid 90s is probably not reliable, but more recent data shows an expansion of

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[1] Barahona AE, (2009) FOOD PROCESSING SECTOR – Acuaodr, GAIN Report Number: EC9002, US Foreign Agricultural Service, Global Agricultural Information Network http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_Quito_Ecuador_3-6-2009.pdf

[2] Ministerio de Agricultura, Ganadería Acuacultura y Pesca del Ecuador, http://www.sica.gov.ec/cadenas/aceites/index.html

[3] Barahona AE, (2009) FOOD PROCESSING SECTOR – Acuaodr, GAIN Report Number: EC9002, US Foreign Agricultural Service, Global Agricultural Information Network http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_Quito_Ecuador_3-6-2009.pdf

[4] Energy Resource, Oct 1 2006, http://findarticles.com/p/articles/mi_m5CNK/is_2006_Oct_17/ai_n24994668/?tag=content;col1.

[5] Ministerio De Agricultura, Ganadería Acuacultura y Pesca del Ecuador, http://www.sica.gov.ec/cadenas/aceites/index.html

COLOMBIA

The Government of Colombia has adopted one of the most ambitious biofuel directives in Latin America. The policy to promote domestic biofuels production and consumption first originated in the previous administration and was formalized by a law passed in 2004 that mandated levels of consumption of both ethanol and biodiesel mixtures of 2% by 2009 and 5% by 2011; although the actual consumption of ethanol is considered to be greater than 6.5% in 2007 and is probably approaching 10% in 2009. This policy is being promoted by the current administration as a strategy for increasing petroleum exports by reducing the domestic consumption of fossil fuels, as well as a way to promote economic growth and job creation in rural areas. The policy explicitly states that the proposed expansion of the biofuel sector should not impact either food security, nor lead to new deforestation. Consequently, efforts are being focused on existing agricultural landscapes where the current productions system is dedicated to low intensity cattle production. Colombia has a robust and diversified agricultural economy, which include the two sophisticated sectors dedicated to the production of the two agricultural commodities that can be converted into biofuel feedstocks: oil palm and sugar cane. The potential growth in the biofuels sector led to the creation of a federation of biofuel producers, [1] following the successful models of producer which represents the sector in the policy debate, along with previously established associations that represent sugar cane (asocaña)[2] and oil palm producers (Fedepalma)[3].

The sugar cane industry is concentrated in the Cauca Valley, where irrigation technology and fertile soils combine to create what the claim to be the most efficient and productive sugar cane industry in the world. Their competitive advantage stems from a 12-month growing seasons that has allowed them to stagger the growth cycle of plantations so that feedstock is harvested and delivered to processing mills at a constant rate throughout the year. In contrast, competitors in Southern Brazil and elsewhere are constrained by seasonal factors that limit the growth of plantations during the cool months of the dry seasons such that the use of processing facilities is restricted from a few months to several months each year (e.g., 3 month in Florida and 9 months in S Brazil). Colombian sugar distilleries are based on Indian technology, which has paid dividends in both efficiencies and the management of liquid waste residues. Currently, all mills are self sufficient in energy while providing 1% of the energy supplies to the national grid; liquid residues pass through a recycling facility that reduces water consumption and reduces effluent discharge by 90% that is used as a soil supplement that reduces fertilizer use. Approximately 25% of sugar cane feedstock is cultivated on lands owned by the corporations that operate the 13 sugar mills located in the Cauca Valley; the remaining 75% is produced by 1,600 independent

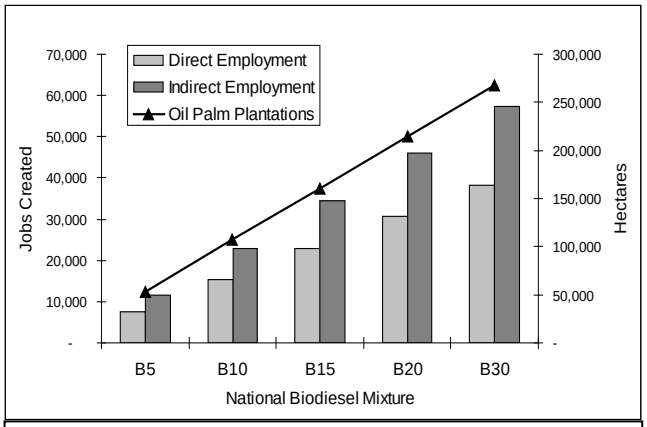

Figure 3. Estimated relationship between oil palm cultivation and job growth from national biodiesel consumption targets

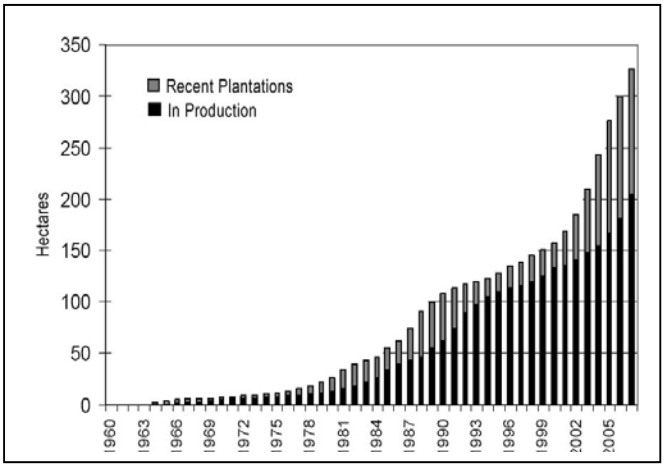

Figure 4. Expansion of oil palm plantations in Colombia; palms begin producing fruits 5 years after establishment.

farmers with long-term contracts. The contribution to the national GDP is estimated at 1%, which represents representing 4% of the rural economy; the sugar cane sector provides approximately 35,000 direct jobs and an estimated 216,000 indirect jobs. [4]

Colombia has produced anhydrous ethanol as a fuel supplement since 2005; currently, five distilleries are operating and a sixth is under construction, producing 365,000 gallons per day, which is enough to provide about 10% of Colombia's liquid fuel demand.[5] Current goals are to increase domestic consumption of to 40%, which would match current levels of consumption in Brazil. The increase in the production of ethanol has impacted sugar exports as it has become more profitable for growers to supply the domestic market. However, the impending approval of the bilateral free trade agreement with the United Sates is expected to increase demand for both sugar and sugar cane based ethanol and the sector is actively engaged in an expansion of capacity. However, the Cauca Valley is essentially fully exploited; currently, about 518,000 hectares are under cultivation, which corresponds to about 60% of the total arable land within the Cauca Valley and there is no idle farm land to accommodate expansion. Consequently, the sugar cane industry is seeking investment opportunities on other regions within Colombia with appropriate climate and soils: the Caribbean coastal plain and the Orinoco Llanos (see map). Both of these areas have appropriate climates, but differ in their historical land-use. The coastal plain is a mosaic of cattle pastures, wetlands and degraded forest, while the Orinoco Llanos is largely an intact savanna landscape, where native grasslands habitats are used for livestock production.

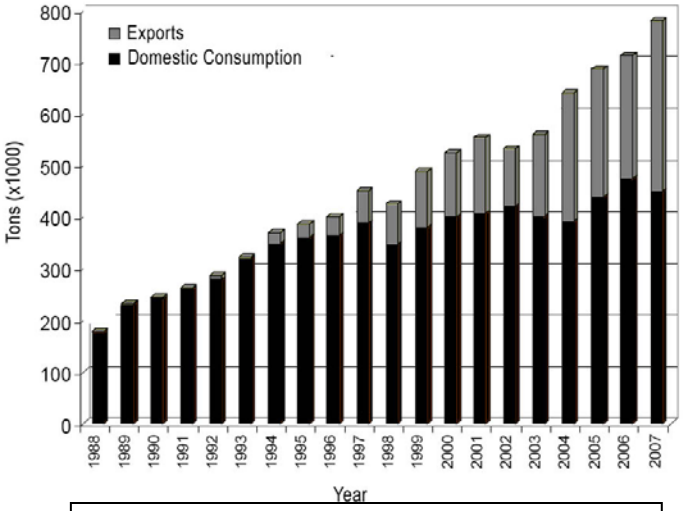

Figure 5. Domestic consumption and export of palm oil: growth in domestic consumption has been flat over the last decade while exports increased; national biofuel mandates will lead to resurgence in domestic demand

The first oil palm plantations in Colombia were established in 1932 and the country is now the fifth largest producer of oil palm in the world (after Malaysia, Indonesia, Thailand and Nigeria). It is the largest producer in Latin America with more than 310,000 hectares of land under cultivation, of which approximately 205,000 hectares are actually producing fruits, a gap indicative of its rapid expansion over the last few years (Figure 4). Colombia has traditionally consumed almost 90% of its oil palm production as food, but in the past ten years exports have increased and now represent almost 40% of total production (Figure 5). As the mandates for biodiesel consumption are implemented, national demand can be expected to grow by at least 50% (Figure 3) and the long term goal of the national federation of palm growers is to triple production, which would allow them to meet not only the demand for domestic biofuels but to respond to opportunities in the export market, without compromising domestic food security.

The Colombian oil palm industry largely follows the large-scale production model developed in Malaysia that consists of linking processing facilities with corporate land holdings, but companies also purchase additional feedstock from surrounding land-holders via long-term contracts. Currently there are 53 processing facilities and more than 3100 producers; although an estimated 28% of the nation's palm growers have yet formally register with Fedepalma's information system that monitors different aspects of national production. As of 2008, there were six biofuel plants in operation or under construction with another three facilities with feasibility studies, when complete Colombia will

have the capacity to produce about 700,000 tons of biodiesel per year, more than sufficient to supply the country with its B20 mandate that is scheduled for the year 2012.

The Colombian oil palm sector has invested in science and technology to manage pests and improve yield, including developing a variety that is a hybrid between the cultivated African species *(Elaeis oleifera* (Kunth) Corte) and a wild species native to the Amazon (*Elaeis guineensis Jac),* as well as a series of integrated pest management techniques that allow producers to avoid or reduce the use of pesticides. However, the most novel innovation and one that differentiate Colombian palm producers from the counterparts in Asia, is the use of irrigation technology to raise yields and extend the potential range of the crop. Oil palm is cultivated in four different regions of Colombia (Figure 6 and 7). Each of these regions has certain attributes which influence its potential for expansion.

The northern and central regions have climates that are marginally appropriate for oil palm and are relatively proximate to coastal ports make them especially competitive for the export market; moreover, these areas have been long settled and plantations would replace cattle pastures. There is, nonetheless, important forest remnants scattered throughout the region, particularly associated on a low mountain range situated between the termination points of the Cordillera Central and there are numerous lakes that form a complex of wetlands separating the Coastal plan from the mountains. According to CENIPALMA, the research arm of the palm grower's federation, each of these two regions together have more than 1.2 million hectares of land that is appropriate for the cultivation of oil palm.

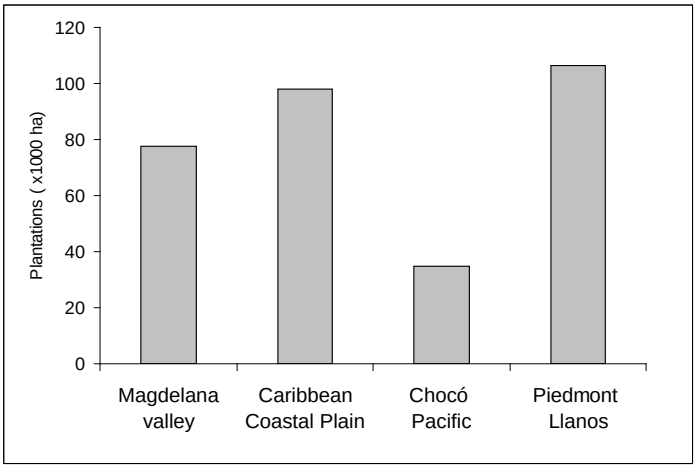

Figure 4. Distribution of palm oil plantations with in Colombia

The Pacific Coast - Chocó region is likewise closely situated to port facilities; however, the extreme high precipitation that characterizes the a liability in terms of pest management and many of the plantations there suffer from a crown rot disease that limits production and in some cases can lead to the abandonment of a plantation.[6] Moreover, this region is well-known for its conservation importance and the past practice of establishing plantations on forested landscape has been harshly criticized by environmental spokesmen, which have been exacerbated by accusation of human rights abuses regarding Afro-Colombian communities that have been displaced from traditional lands. Apparently, only 66,000 hectares are considered to be appropriate for expansion of oil palm plantations; this region represents the smallest and most problematic component of the oil palm sector in Colombia

The region considered to have the greatest potential for the future expansion of oil palm cultivation. It includes several provinces that straddle the strip of tropical rain forest on the Andean Piedmont that separated the mountains from the open grasslands of the Llanos del Orinoco. This is already the region with the greatest area under cultivation (Figure 6) and, according to CENIPALMA, has the greatest potential for future expansion with about 1.9 million hectares. However, this apparently large number also includes both native and converted habitats; the government and Fedepalma's commitments to expand production without cutting down trees, does not include a corresponding commitment to avoid the conversion of natural savannas. Most of the earliest plantations were established on forest landscapes following deforestation, while most of the later expansion was focused on the conversion of cattle pasture. However, future expansion would include what is still native grassland, in spite of its inherent fertility.

Colombia has the most ambitious biofuel program in Latin America after Brazil, but in contrast to Brazil's program, which is mainly based on sugar cane ethanol, Colombia proposes to

have a more diversified biofuel strategy that places biodiesel on par with ethanol. The expansion of the sugar industry would appear to face more challenges, because it must expand into new geographic areas, while the oil palm sector just needs to expand plantations within previously established production zones. More ever, both may end up competing for available land because both sectors have identified the same regions as potential areas for the expansion of their production model, in spite of the clearly

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[1] http://www.fedebiocombustibles.com/quienesomos.htm

[2] Asociación de Cultivadores de Caña de Azúcar de Colombiahttp://www.asocana.com.co/

[3] Federación Nacional de Cultivadores de Palma de Aceite http://www.fedepalma.org/

[4] Asociación de Cultivadores de Caña de Azúcar de Colombiahttp://www.asocana.com.co/

[5] Toasa. J (2009) Colombia: A New Ethanol Producer on the Rise? / WRS-0901, Economic Research Service/USDA http://www.ers.usda.gov/Publications/WRS0901/WRS0901.pdf

[6] The hybrid variety from the cross between *E. guieneensis x olifiera* is resistant to this blight and is being promoted as a solution to the agronomic limitations of the zone.

PERU

Peru is following the pathway pioneered by Colombia and has embarked on an ambitious program to convert a significant portion of its domestic energy consumption to biofuels. Like Colombia, the Peru intends to expand its production and consumption for both biodiesel and ethanol. Initial mandates went into effect in 2009 with a 2% mix required for diesel fuel, which will increase 5% in 2011; an ethanol mix (E7.8) is scheduled to be implemented in 2010. In both cases, mandates are well above domestic capacity and initially the country will have to import feedstocks, while investments are made in domestic production.

Ethanol production will be derived from an expansion of Peru's existing sugar cane cultivation, which is largely concentrated on the coastal desert plain and relies on irrigation technology dependent on rivers that flow out of the Andes. Within this desert landscape, the availability of water from both surface flows and aquifers increases from South to North due to a variety of geographical and climatic phenomena. [1] More than 80% of national production comes from two Northern provinces: Lambayec (Chiclayo) and La Libertad (Trujillo), with about 15% is produced in the province of Lima and the Southern Coast. The rest is distributed among intermountain valleys with abundant water supplies, but which is largely dedicated to the production of crude sugar and alcohol for local consumption. As in Colombia and Ecuador, production efficiency in the northern desert is facilitated by its near equatorial location and the subsequent a 12 month growing season; most of the plantations are on alluvial soils with relatively high latent fertility. Finally, since crops are produced year round, sugar mills have higher potential rates of return when compared to sugar mi8lls in most subtropical regions.

Peru has a total of 13 sugar mills and has cultivated between 60,000 and 77,000 hectares over the past three decades;[1] approximately 65% of this total is dedicated to corporate plantations directly linked to the mills, while the remaining plantations are in the hands of independent growers. To meet the projected increase in demand from biofuels and eliminate the import of approximately 25% of current national consumption of refined sugar, current production must be increased by a factor of three. However, the capacity to expand irrigation in the traditional cultivation areas of the northern desert will be problematic due to constraints on water supplies. The northern coastal desert currently produces almost two thirds of Peru's agricultural GDP, which include staples such as rice, sugar and cotton, as well as important high value crops that provide 10% of its total national exports. For example, Peru is the world's largest exporter of asparagus and all of this production is based on irrigation agriculture in the northern Peruvian desert. Sugar cane farmers will only be able to expand as water use efficiency is increased across all sectors.

The largest current expansion in sugar cane plantations is occurring in Piura, the only northern coastal province that lacked an industrial sugar cane facility. Three separate groups have initiated investments that range between 7000 and 8000 hectares each; these include La Fabril (Ecuador), Grupo Romero (Peru) and Maple Oil (Peru). The later corporation is a Peruvian entity with international shareholders (Canadian), but also includes Peruvian pension funds and the World Bank. Beyond the northern coastal desert, the areas with the greatest potential would be the semi-arid upper valley floor of the Marañon River (Amazonas) and the semi-humid valley floor of the lower Huallaga River (Loreto). However, some analysts also identify the Amazon lowlands as potential area for expanding sugar cane plantations and small scale producers are being organized to produce ethanol for local markets in lowland Amazonian cities such as Pucallpa.

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[1] The Peruvian coastal desert is referred to as the *Sechura* Desert by geographers and is bordered by the Tumbes Dry Forest in the North and the Atacama Desert to the South. Its formation is due to the cold waters of the Humboldt Current that inhibit convection causing this area to be one of the most arid landscapes on Earth. Surface aquifers are linked to rivers, which depend on precipitation in the high Andes, which is almost entirely dependent on orographic rain originating over the Amazon. The internal drainage system of the Altiplano capture most of this precipitation in South Peru, while river basins in Northern Coastal Peru receive higher precipitation due to the Huancabamba Gap, where moisture-laden Amazonian air pass through the Andean Cordillera.

Domestic production of biodiesel also slated to increase dramatically over the next few years; the government imposed biodiesel mandates before sufficient domestic production capacity was installed, which obligated fuel companies to import vegetable oil. Biofuel feedstocks will be supplied by a combination of three crops: oil palm, jatropha and rape seed. Oil palm has been produced for 30 years in the Upper Huallaga Valley (Loreto) at the Palmas del Espino" estate owned and operated by the Romero Group, one of Peru's largest industrial and agricultural conglomerates. This estate is located in what has been one of the most conflictive region of Peru, centre to one of Peru major coca production regions and, for a period in the 1990s, a major operating ground for Marxists guerrillas. *Palmas del Espino* will expand its existing 10,000 hectares by an additional 30,000 hectares by 2015, while simultaneously encouraging small farmers to cultivate palm oil to supplement corporate production and to improve relations with neighboring communities. The Romero Group has a new venture, Proyecto Shanusi, which includes an 8,000 hectare plantation and associated mill near Yurimaguas (Loreto) in the northern part of the country; this project, unlike the Palmas del Espino plantations, will be exclusively dedicated to biodiesel production at an estimated cost of $50 million.

Oil palm has been cultivated near Pucallpa in Central Peru for at least two decades, where ~7000 hectares grown by small farmers are serviced by a small cooperative mill. More importantly, Central Peru is the focus of one the most ambitious biofuel investments on the continent. Pure Biofuels, a US Corporation established in 2006, plans to establish 80,000 hectares of plantations near Pucallpa in order to supply its 52 million gallon refinery that was recently constructed in the port of Callao. Apparently, they planned originally to grow oil palm, but more recent reports have highlighted that jatropha as the predominant feedstock. Jatropha is generally considered to be adapted to seasonally dry or semi-arid climates, so the decision to plant it in a region with mean annual precipitation greater than 2000 mm is surprising. Pure biofuels has established a nursery in the region that can produce 1 million seedlings per month and had plans to establish 1000 hectares per month. In a separate effort, Pure Biofuels has entered into collaboration with the Dutch Development Agency (SNV) to establish 6000 hectares of jatropha in Piura by small farmers, which is expected to improve the livelihoods for hundreds of impoverished families and create more than 1000 jobs from both direct and indirect employments.

Venezuela

The government of Venezuela has opposed the development of biofuels alluding to the potential competition between food supplies and energy markets. Nonetheless, in 2006 the government announced a plan to produce ethanol as an additive for gasoline; [2] the motivation for this policy is not to introduce biofuels, per se, but to replace the importation of ~10 million barrels of ethanol from Brazil. Like most Caribbean countries, Venezuela has a long tradition of sugar cane cultivation and in the early part of this decade had more than 130,000 hectares under cultivation with 14 sugar mills, most of which are located in the states of Zulia and Portuguesa. Sugar cane plantations are overwhelmingly composed of small and medium sized indep3ndent farmers; . However, the country imports about 25% of its refined sugar consumption and does not currently produce the anhydrous ethanol required as a fuel additive. The proposed expansion would double the area under cultivation and build an additional 11 sugar mills; the expansion is to be undertaken with the technical assistance of Cuba. In spite of the announced policy, sugar cane production has fallen over the past three years and the announced investments have not materialized. Similar commitments to expand oil palm plantations and to invest in biodiesel production with the assistance of Malaysia have like wise not materialized. Venezuela has ample land surface available for the expansion of sugar cane cultivation and could cultivate oil palm using the same technology available in Colombia, which shares similar climate and soils.

Bolivia

The Government of Bolivia has stated that it is opposed to biofuels and has no policies to promote the production or consumption of biofuels. Nonetheless, the private sector in Bolivia is actively promoting biofuels, including both sugar cane ethanol and biodiesel. Bolivia has about 100,000 hectares under cultivation and five sugar mills; several of these mills produced alcohol, none of which is consumed domestically as a biofuel, but is a high quality product that is exported to Europe for use in the perfume industry. Sugar cane farmers have expanded the area under cultivation in the past few two years and sugar mills have expanded capacity to take advantage of high commodity prices, but a political instability has impeded investment in new processing facilities, which would be required to expand production to other regions.

Bolivia is a producer and exporter of hydrocarbons, but experiences significant shortfalls in meeting national consumption, particularly for diesel, which is subsidized at below market level prices. Between $100 – 300 million is expended annually to import diesel and the largest consumers of diesel are soybean farmers; analysts at the Bolivian Institute for Exports (IBCE) have conducted a feasibility study that purports to demonstrate that converting . The

[2] Venezuela was one of the world's largest consumers tetra-ethylene lead based fuel additives to improve octane levels in gasoline; a practice that was phased out starting in the year 1999.

[1] Dulce energía: el repunte de la caña de azúcar, *AgroData-CEPES* http://www.cepes.org.pe/revista/r-agra96/LRA96-02.pdf