Biodiesel from sustainable palm oil on degraded land at El Cimarrón, Colombia

By Henrik Wiig (PhD), ResGrow AS

A business development plan for Prestige Colombia SAS, draft March 14, 2017

Project: El Cimarrón
Location: Nueva Antioquia, Primavera municipality, Vichada department, Colombia
Product: Biodiesel and CPO from certified sustainable palm oil on degraded land
Life-cycle GHG emissions savings: 134% of fossil fuels, satisfying EU-RED
Certification: ISCC RED, POIG, RSPO
Companies: Prestige Colombia SAS and Extractora Cimarrón SAS
Owners: Ole Martin and Kristian Siem
Development: Greenfield 60,000 ha African palm, 5 extraction mills, 1 refinery, 1 plant
Investment in planting: USD 480 mill: 8,000 USD/ha
Investment total: USD 770 million
Harvest period: 4 – 25 years after planting
Fresh fruit bunches: 1,200,000 mt annual production with average yield 20 mt/ha
CPO: 252,000 mt annual production with 21% oil in fruit bunches
Kernel oil: 24,000 mt annual with 2% in fresh fruit bunches
Kernel cake: 30,000 mt annual with 2.5% in fresh fruit bunches
Biodiesel converted from CPO: 280 million liters PME, CPO density 0.9 kg/liter
Norwegian diesel consumption: 3,741 million liters; El Cimarron will cover 7.5%
Gross total production value: 210 million USD annual with no sustainability markup
CPO value: 171 million USD/year with 680 USD/mt CIF Europe
Kernel oil value: 35 million USD with 1,466 USD/mt FOB Malaysia
Kernel cake value: 4 million USD with local Colombian price 135 USD/mt
Biodiesel alternative consumer value: 508 million USD, 1.8 USD/liter in Norway
Expected employment: 6,000 full-time workers
Expected urbanization: 75,000 inhabitants if a regional agricultural cluster develops

Executive summary

Global warming is a threat to mankind. The substitution of fossil fuels with low carbon energy is needed to reduce emissions of greenhouse gases. The European Union (EU) impose 10% sustainable energy in the transport sector. The Norwegian government will enforce 20% biofuels for road traffic by 2020, but there is not sufficient sustainable product on the market. Prestige Colombia SAS identifies an area in in Los Llanos, Colombia, that can be planted with 60.000 ha palm to produce biodiesel which comply all social and environmental standards. The annual production of 280 million liter biodiesel can substitute 7.5% of the fossil diesel consumption in Norway. The initial investment in plantation, five extraction mills, one refinery, one biodiesel plant and other infrastructure is 770 million USD, and annual gross sales income 210 million USD.

The land is degraded by extensive low productive cattle herding and there are no trees on this natural savannah. The new palms hence capture more CO2 than what is emitted in the biodiesel production process. Independent life cycle analysts estimate a *134 percent* reduction in emissions of greenhouse gas (GHG) which satisfy the EU Renewable Energy Directive. The state-of-the-art production system converts residuals and process effluents to natural compost, reducing fertilizers application and GHG emissions. The biodiesel will be shipped on river barges and then tankers to Europe. The land is ideal for palm cultivation; close to equator, low altitude, high temperature and much rain as the dry season is short. Irrigation is not necessary and eutrophication is hence only a minor risk. The gallery forests in the small belt along the rivers and creeks, as well as wetlands, will be protected and land set aside for wildlife corridors, protecting about 25% of the area. Academic studies demonstrate that the conversion of such degraded land to palm plantations increase biodiversity.

The Colombian revolutionary armed forces (FARC) and the government just signed a peace agreement ending 50 years of conflict. Law and order with development of state institutions in the countryside is the most important element to secure lasting peace. The new law on industrial agriculture allows the state to rent out land to agribusiness in low populated areas without infrastructure. The project will hence combine own property, rented state land, land reform beneficiaries and neighbors in the common project. An estimated 6000 jobs represents an opportunity for the rural poor to live a decent life, substitute coca cultivation that sustain criminal networks and reintegrate demobilized FARC guerrilla soldiers.

There are three small indigenous groups with a total population of 600 individuals in a reserve about 15 kilometer outside the proposed plantation area. These make their livelihood by fishing, hunting and small scale agriculture close to the river and do not use the savannah.

It will take considerable time to plant 60.000 ha. Prestige hence proposes a collaborative effort with four other producers in Los Llanos to scale up the project rapidly and be able to deliver most of the biodiesel by 2023-24. The land in Los Llanos is homogenous and the other producers are hence expect to qualify for the intended POIG and ISCC RED certification too. It is also possible to combine palm with parcels for cattle, corn and other foods to reduce the extent of mono-cropping.

1 Introduction

Today it is widely recognized that global warming is caused, at least in part, by anthropogenic emissions of greenhouse gases (GHG) with the concomitant climatic changes. The agreement reached by the United Nations (UN) member states in Paris 2015, on implementing policies aim at limiting global warming to less than 2°C, ideally 1.5°C, has been hailed as major breakthrough. However, continued population growth and aspirations of higher living standards in developing countries will make it difficult to achieve that climate target.

The European Union (EU) has independently issued directives (regulations) that oblige its member states to reduce GHG emissions. By 2020, sustainable renewable energy sources that are almost carbon-neutral are to constitute 20% of total energy consumption, with biofuels as a major source—intended to cover 10% of energy consumption in the transport sector.

Technologies and cost levels for alternative energy free of GHG emissions are still in their infancy. Conventional biofuels based on food crops are already in use, and are expected to play a central role in facilitating a rapid shift to a green economy, especially in the transport sector. However, few biofuels today comply with all requirements for being truly climate-, environment- and development-friendly. The European Union's Renewable Energy Directive (EU-RED) only accepts new biofuels that reduce emissions by 60% in a life-cycle analysis compared to fossil fuels, respect indigenous groups, do not destroy virgin nature and do not displace food production. European politicians have been imposing biofuel blending by law, while refineries and gas stations struggle to obtain sufficient quantities of sustainable biofuels in the global market.

Biofuels currently grown in former rainforest in developing countries do normally not qualify as "sustainable" under the EU-RED definition. However, there exist large areas of degraded lands in this part of the world with extremely low productivity that might be converted to biofuel production without harming nature or reducing food production significantly. We have identified one such area in Colombia and Venezuela: about 40 million ha (hectares) of land, with the potential to produce low-GHG-emission biofuels that could satisfy European demands for a long time to come. The cultivation of African palm in these areas would comply with all environmental and social requirements, while the associated investments in infrastructure could also promote greater food production. Finally, the increased biomass of the African palm stores carbon, and its cultivation improves the soils. In short, it is possible to plant a forest that also yields biofuels to be harvested three times a month.

Prestige Colombia SAS (hereafter Prestige) and its sister company, Extractora Cimarrón SAS, run a palm-oil farm and extraction mill, respectively, on their El Cimarrón farm of 13,000 ha in the Vichada department in Los Llanos region of Colombia by the Venezuelan border. The Norwegian owners Ole Martin and Kristian Siem represent a unique combination of proven innovative and managerial capacity with sufficient capital and knowhow to develop large-scale projects that can spur further regional and sectoral growth. The former runs the export-oriented agricultural company Frupor in Portugal, while the latter is the chairman of Subsea7, which develops high-tech seabed oil installations in deep waters of Norway and Brazil. They jointly manage Siem Shipping with a considerable share of world trade on refrigerated vessels and car carriers, and the oil service company Siem Offshore.

Their vision is to contribute to alleviation of the climate crisis by rapidly expanding the cultivation of palm oil for sustainable bio-diesel on these currently degraded lands. This business development plan of 60,000 ha greenfield palm-oil plantation aims at producing biofuels sufficient to meet all current demand for biodiesel resulting from the current 5.5% blending mandate in Norway. The government has recently decided to raise the requirement to 20% by 2020 (PoN, 2016). However, Prestige could manage to supply also this increased amount, as the project is easy to scale up. There is plenty of idle state land close to the farm that can be made available by the Colombian government, through a private–public partnership, to create a sustainable economic, environmental and social project over the next 30 years.

We consider the project to be technically feasible and politically viable, given the new context of peace in Colombia. Independent experts of life cycle analysis in Quantis International verify that the EU RED requirements of 60% GHG emission compared to fossil fuels are met as the El Cimarrón project gives 134% reduction, see twin report of Gmünder (2017). With Prestige's labor practices and the fact of no competing territorial claims from indigenous people on El Cimarrón, it should not be difficult to obtain valid certification as an environmental and social sustainable producer. Some other producers in Los Llanos already have Roundtable of Sustainable Palm Oil (RSPO) certification. Prestige also aims to get certification from the more restrictive Palm Oil Innovation Group (POIG) charter, which has been formulated and accepted by many civil society organizations. This business development plan hence pre-empts the independent certification process that will be commissioned and completed before any commercial contracts are signed.

The aim of this report is to investigate and demonstrate all aspects that are relevant for the

technically feasibility, socially and environmentally sustainability of the proposed biodiesel project at El Cimarrón in a transparent manner The report provides only indications as to profitability: the exact investment and production costs and hence sales prices will be calculated by Prestige later.

2 Climate and sustainability

2.1 Cooperation to mitigate global warming

Global warming has long been recognized as a threat to the future of human life on Earth. The prevailing consensus is now that human activities are to blame, through emissions of greenhouse gases (GHG), that diminish the ozone layer and hence allows more sunrays to enter the atmosphere is one of several negative effects. To promote cooperation to reduce GHG emissions, the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro developed the Framework Convention on Climate Change (UNFCCC). This "climate convention" is an institutional framework for negotiation between the signatory countries (parties) who meet in Conferences of the Parties (COP) to define concrete action plans. At the third meeting in Japan, the countries agreed on the Kyoto Protocol for regulating GHG emissions from mainly industrialized countries. The most recent breakthrough came at COP21 in 2015, where 195 countries agreed to the Paris Agreement on limiting global warming to less than 2 degrees Celsius (°C) compared to pre-industrial levels, with more ambitious long-term goal of 1.5°C (UNFCCC, 2015). The agreement further defines national goals and procedures for drawing up action plans and tightening the goals in the future.

The European Union is an important driver behind the UN climate process and has acted independently to reduce GHG emissions from its member countries. The EU Commission has prepared several "roadmaps" on how to achieve the targets, guided by policy signals from the heads of state/government gathered in the European Council. The latest energy roadmap on achieving a near-carbon-neutral society by 2050 (i.e. reduce GHG emissions by 95% compared to 1990 emissions levels), emphasizes increased energy efficiency and using energy sources with no net carbon emissions as the solution (EU, 2011).

In April 2009, the Council of the European Union and the EU Parliament adopted the Renewable Energy Directive, RED (2009/28/EC) for the promotion of energy from renewable sources, referring to commitments under the UNFCCC Kyoto Protocol. As per the RED, by the year 2020, the EU on the whole is to improve energy efficiency by 20%; 20% of all energy

consumption is to be from renewable sources; and 10% of energy in the transport sector is to come from renewable sources (EU, 2009). National obligations for total energy use differ among the member-states, depending, inter alia, on their access to sustainable energy. But all countries must comply with the 10% requirement for the transport sector, since biofuels are easily traded between countries. It assumed that other sources of sustainable energy (wind-, solar-, wave-power etc.). that might be transformed into electricity will be difficult to use efficiently in many parts of the transport sector. Electric engines might replace traditional combustion engines for personal transport, but it will be difficult to replace diesel in buses, heavy long-haul transport, airplanes and sea vessels. Biodiesel is probably the only realistic alternative for such modes of transport for a long time to come

The EU Directive further stresses the importance of international trade: "while it would technically be possible for the Community…solely from domestic production, it is both likely and desirable [to employ a] combination of domestic production and imports" (EU, 2009, p. §16). This emphasis on imports of biofuels probably reflects the fact that most production of biomass for biofuels within EU would necessarily displace current food production.

Advanced biofuels from non-food biomass—for example, extracted from forests—are technically difficult and are not a cost-competitive alternative in the foreseeable future (NER, 2016). On the other hand, the EU emphasizes the innovative aspect of creating new sustainable energy, with short transport distances favoring production close to the point of consumption—thereby also promoting local employment and economic growth.

The European Economic Area (EEA) countries (currently Norway, Iceland and Liechtenstein) are not full members of the EU, but must comply with EU RED by issuing or amending their national legislation in order to fulfill their EEA obligations. Norway introduced the compulsory blending of 5.5% biodiesel into diesel in 2015. The government increased this requirement one year later to 20% by 2020. Of this, at least 8% must be advanced biofuels. However, EU RED allows these to "count double," implying it will be necessary to have only 4 liters of biofuels out of every 100 liters of diesel (PoN, 2016).

However, Norway had even difficulties in fulfilling the 5.5% requirement. An analysis of how to achieve a carbon-neutral society by 2050 commissioned by the Nordic Council of Ministers and the International European Agency (EIA) has calculated that biofuels will constitute 67% energy consumption in the transport sector by 2050. A major share will be conventional, as the

analysts doubt that advanced biofuels will be competitive on the market (NER, 2015). The report indicate that 16% of all biomass energy will be imported, mostly from land-abundant and population-sparse countries outside Europe, e.g. Latin America, some countries of the former Soviet Union, and Canada. These countries can increase agricultural production for both biofuel and food at the same time.

Forest products are considered as the prime source of advanced biodiesel in the Nordic countries. However, it will take a long time for the trees to grow and capture the same amount of carbon as released—about 80 years to recover the carbon debt, compared to burning fossil fuels which hence might be a more climate friendly alternative in the medium term (Holtsmark, 2015). In comparison, palm first capture CO2 when planted and then releases afterward. Furthermore, the CO2 cycle of the annual palm oil and food crop production and has hence no storage or leakage effects at all.

Climate policies in Norway and other European countries thus indicate large imports of conventional sustainable biofuels as the most likely scenario for the coming decades. Los Llanos in Colombia stands out as a highly suitable areas for cost-efficient sustainable biodiesel.

2.2 Regeneration of degraded lands

Today's Colombia is a medium-income democratic country with fairly well-developed formal institutions and rule of law. Furthermore, it is the Latin American country with the longest uninterrupted history of democratic governments. Average GDP per capital was USD 8,858 in 2015. However, the country is split in two: the high-income urban areas with rule of law, and the low-income countryside with only a limited presence of the state. Guerrillas, criminal groups, paramilitary groups, and local power-lords control much of the countryside (Robinson, 2016). This situation is set to start changing, thanks to the signing of the peace accord between the FARC guerrilla and the Colombian government. An "Integral rural reform" is the first and most important element that will lead to changes in the countryside. New infrastructure, state support programs, education, etc. will finally reach the impoverished people neglected by the state. However, without decently paid employment, the state-building project will fail. Therefore the government plans to distribute state land to small-scale and landless rural inhabitants, at the same time opening for "associative production" between small-scale farmers and the agro-industry, to make the production chain more efficient[1]. In a parallel legal process,

[1] The perception of associative production as linking poor to the industry is problematic of two reasons. First, the owners of a UAF that decide to take part are not the poorest segments of the population, and they tend to hire

the Colombian Congress passed the ZIDRES law for agro-industrial development, whereby the government will rent large land-areas to the agro-industry on 30- to 50-year contracts (see section 6 below). The changes will boost both small- and large-scale agriculture, thus vitalizing the countryside.

Colombia is divided into five geographical regions: the Pacific Coast with rainforest; the Andes Mountains and valleys; the Caribbean Coast with plains; the Amazon River catchment area; and the 38 mill. hectare Orinoco River catchment area (see map, Appendix 9.1). The Orinoco area features two main land types. To the south there are about 18 mill ha of rainforests; and to the north, 20 million ha of natural grassy savannahs known as Los Llanos, with trees along the many rivers. The two northern departments of Casanare and Arauca are flooded during the rainy season, and there is now a discussion whether these shall be defined as wetlands that are protected through international conventions. By contrast, Meta and Vichada (13 million ha, known as the *Altillanura*, high plains) are never flooded. The Altillanura is considered optimal for agricultural expansion, and has been prioritized for development by the Colombian government.

The Los Llanos savannah lands continue on the other side of the border, with another 20 million ha of mostly degraded land in Venezuela. The total potential area for sustainable agriculture is hence more than 40 million ha—see map in Appendix 9.2

3 The production process at El Cimarrón

3.1 Access to land

Prestige's project design consists of a 60,000-hectare plantation of African palm for producing biodiesel in the municipality of Primavera, Vichada (see map, Appendix 9.3). The company holds registered property titles to 13,000 ha of this area, planning to rent adjacent idle state lands and include neighboring land owners in the operation in order to achieve the planned size to entail economy of scale in production. The company expects the state to be willing to rent out land, as this region of Vichada satisfies the requirements of the ZIDRES law.

The project will be one large integrated production unit, but excluding environmentally vulnerable areas as defined in the RSPO 2013 principles and criteria for Colombia and no-go

dayworkers to do the actual job as the fruits must be harvested all in one day not to be spoiled. Secondly, as the industry starts to organize labor groups that rotate amongst the small land owners in order to increase efficiency and improve and formalize labor conditions for the once to do the actual, the role of the participants is then reduced to be small scale land owners only. Creating a class of small scale capitalist is hardly the intention of the policy.

land as defined by EU RED (EU, 2009; RSPO, 2016). Plantations are not to be closer than 100; Prestige has self-imposed a 200-m limit, from forests along rivers and creeks; it avoids peat soils and other fragile soils, steep terrains with more than 12% gradient, and wetlands, and leaves natural corridors and buffer zones for endangered species and wildlife corridors. The total need for land is hence 80,000 ha, assuming that maximum 25% is not to be planted. We do not consider area needed to produce food to the workers and their families since such does not represent a net national increase since they are already fed.

3.2 Farming practices

There is a need for investment in the land to enhance its productivity. The estimated investment costs for preparing the land during the first pre-production years are about USD 8,000 per hectare, for soil rotation, supply of nutrients, irrigations systems, planting, and maintenance. Total investment costs will hence be USD 480 million for land preparation, planting, and maintenance.

The project seeks to mechanize the farming process, but many parts of operation will still require manual labor. The fruit bunches are manually cut from the palm plants, collected, and put on tractor trailers by hand and then driven to the extraction mill.

The agricultural practice is described in detail in the twin report on GHG emissions (Gmünder, 2017). It includes emissions from use of industrial fertilizers. Other inputs produced elsewhere that reduce GHG emissions is *not* included in the calculation. One such example is Biochar, i.e. trees burned to charcoal. Prestige will establish forest plantations on El Cimarrón in order make charcoal that will be broken into small pieces and incorporated in the soil. This biochar improves soil quality, *inter alia* by boosting water retention capacity, and represents a technique developed and applied in Latin America already in pre-Columbian times (Wikipedia, 2017) and now adapted with success in other the world like rice in Africa (Norges Vel, 2014). Most importantly, it does not dissolve and hence represents an important carbon sink which reduces the GHG emissions of the sustainable biodiesel even more. The use of the palm itself after production ceases is neither included in the calculation of GHG emissions according to EU RED methodology. Rather than leaving to release CO2 in a natural decaying process, Prestige can sell them as input to the energy production of the Forest First production line further down by the Meta river and thereby further reducing the real GHG emission.

3.3 The extraction mill

Expected average production on the 60,000 ha of African palm on the El Cimarrón plantation is 21 mt (metric tonnes) fruit of oil palm per hectare per year. The palm starts bearing fruit four years after planting; commercial production stops after 25 to 30 years, as the palm grows too high to be harvested. We hence use an average yield for all 25 years, not the yield for the mature palm. Total harvest on the 60,000 ha plantation will thus average 1.2 million mt with the volumes varying slightly over the years. Prestige prefers to build five normal-sized extraction mills with processing capacity of 300,000 mt each a year, as technically more reliable in operation. Lower production costs will be achieved by constructing the mills in separate locations, to minimize transport distance from the field.

The residuals and liquid effluents from the extraction process will be processed into bio-compost, and represents a groundbreaking innovation and investment to reduce GHG emissions previously considered to be the main source of emissions and water pollution in the palm industry. Prestige is now investing in a bio-compost facility at its current 625 ha pilot plantation. The residuals, except for hard nut-shell, are first cut into pieces mechanically and piled up under a roof with open walls. The effluents, such as. extraction process water with biomass particles, is then sprayed on top, with fresh air circulating from below and within the piles to dry the material. The aerobic process emits some CO_2—which is, however, less harmful than the methane gas from anaerobic decay in waste water, and is just as climate- and environmental friendly as the alternative of capturing methane gas from pools of waste water to produce electricity (see Appendix 9.4). The finalized compost will be used to fertilize the palms.

Heat and steam are needed in the extraction process. Palm fruit residuals, especially the shells of kernel nut and fibers from fruit mesocarp, will be burned in boilers. These boilers will produce the electricity needed for the production facility and the housing quarters by steam turbo alternators or Organic Rankine Cycle (ORC) technology, sold by Viking Heat Engines, among others. The diesel needed to start the extraction mill after complete halts due to holidays or technical problems will come from the farm's biodiesel plant. Thus, the project is self-sufficient in energy, with no need to bring in diesel or electricity. Although being connected to the national electricity grid would facilitate processing, it would also represent a risk, as electricity supplied from the public grid is highly unreliable. Moreover, no such grid exists in the area today, although the state will probably establish a grid in Primavera municipality in the foreseeable future. Construction costs for the extraction mill are estimated to USD 500,000 per

mt/hour processing capacity; the five mills will have 60 mt/hour each and a joint capacity to process 1.5 million mt annually. That makes total investment cost in the mills USD 150 million.

3.4 Refinery

The crude palm oil (CPO) will be piped to a standard refinery and production plant for biodiesel to be built on the banks of the Meta River biodiesel. Average transport distance of CPO from the extraction mills will probably be on average about 25 km. Optimal refinery capacity will be 1,000 mt of CPO a day, to be able to handle peaks in the main harvest seasons. Expected oil content in the fruit is 21%, so 1.2 mill mt fruit will be converted to 252,000 mt CPO each year. Prestige will construct the port facilities for loading the refined biodiesel directly onto barges.

The plan is to produce biodiesel, but it will also be possible to sell CPO instead: the mix will depend on relative market prices and obligations from long-term contracts. Both the CPO and the biodiesel will be shipped on barges, mostly downstream as export to the global market, but also upstream to satisfy local demand in Colombia.

We expect the following seven products: crude CPO, refined CPO, PME biodiesel, olein, stearin, kernel oil, and palm kernel cake. The latter will be used as cattle fodder, sold to independent local operators or own cattle herding at El Cimarrón, thereby utilizing all bi-products from the operation. Total estimated investment cost of the refinery is USD 100 million.

There is a general challenge of using a high share of PME in biodiesel in low temperatures. Producing Hydrotreated Vegetable Oil (HVO) instead of PME will solve the problem, although as a more expensive solution will such increase the final price to the consumer. However, the product will still be price competitive as the new policies enforcing biodiesel mixtures will increase demand far beyond the volumes available today in Europe.

3.5 Transport to Europe

The product will be loaded directly onto tank barges from the refinery on the banks of the Meta River. The river is navigable for much of the year (May to December); water levels are too low in the normally four months of dry season (January to April). The maximum barge size on the river is 600 mt with reaches of between 1.50 and 1.80 m deep. During the dry season, the product will be loaded on trucks and driven 270 km to Puerto Carreño, for loading into barges in the Orinoco River (see map, Appendix 9.11). The Orinoco, the second most important water artery in Latin America, is sufficiently deep all year to allow 1500 mt barges. It will be possible to reload from the 600 mt refinery barges to 1500 mt barges at the point where the two rivers

meet. Low bridges crossing the Orinoco River in Venezuela prevent transport boats or tankers with higher superstructures.

Commercial activity on the Meta is currently low, mainly barges bringing standing cattle upstream to Puerto Lopez. Prestige plans to bring today's small-scale palm-oil production from the pilot plantation on trucks transported on barges upstream to Puerto Lopez, the point of entry to the capital Bogota and the populous Andean highlands.

Diego de Ordáz explored the Meta River in 1531 and undertook several expeditions in search of the fabled gold of El Dorado. Steamers passed all the way to Rio Cravo in the 1800s. In recent times, there has been some steel import on barges upriver from Venezuela. The most recent plan for creating a commercial transport route was in connection to Cargill`s maize (sweet-corn) plantation in Colombia. Both the plantation and the transport company closed down in 2011. However, the prospects of Prestige and other producers in Vichada have led current small-scale river transport companies to begin expanding their activities on the Meta.

The Orinoco River is defined as international waters but runs through Venezuela, which currently has low government institutional capacity. Other large companies in the area are now lobbying the Colombian and Venezuelan governments to secure the viability of the Orinoco as an international transport route. Forest First, a Colombian company with both local and international investors, has established large forest plantations in Vichada with the intention to sell charcoal and firewood chips to Europe when the trees are ripe for harvesting after four years[2]. The Santo Domingo group is currently seeking to establish a permanent transport route on the Meta and the Orinoco.

3.6 Volume and income calculations

Here we summarize volumes and potential income estimations as given in key figures, but do not intend to estimate the production costs or project profitability. We apply market prices without including any markup for delivery of sustainable products compared to the current market price for CPO produced in rainforests.

[22] Forest First has so far invested 35 million USD in a tree plantation and has no other possibility than to ship out on the Orinoco river through Venezuela as any alternative route will be too costly for such heavy products. They plan to use barges under Venezuelan flag to ease the political challenge. They believe several barges might be pushed all the way from Puerto Carreño, but the viability of such method is not proven since most Venezuelan transport initiate at the bauxite mines 150 km down river from Puerto Carreño. There are rumors about rapids that might cause problems for "trains" of several barges that are pushed by a tugboat, but this can be solved by leading the barges one by one to pass this possible critical stretch of the river.

Assumed average yield on the 60,000 ha planation at El Cimarrón is 20 mt fruit per hectare as Prestige does not intend to use irrigation, hence annual production of 1.2 million mt. The content of palm oil is 21%, kernel oil 2% and kernel cake 2.5%, hence an annual production of CPO of 252,000 mt kernel oil 24,000 mt and kernel cake 30,000 mt. Reference price for CPO is USD 680 /mt CIF Europe, hence USD 171 million in annual sales income. Kernel oil is 1,466 USD/mt FOB Malaysia, hence USD 35 million; and kernel cake 135 USD/mt local Colombian price, yielding USD 4 million in income. The total gross income is hence USD 210 million per year, leaving out possible sales of other minor bi-products from production process, for instance stearin.

The CPO will be converted to 280 million liters of biodiesel (Palm Methyl Ester, PME) with an approximated density of 0.9 kg CPO per liter of biodiesel. Current price of diesel in Norway is USD 1.8 /liter in December 2016, making total annual gross income from sales to the consumers USD 508 million.

The investment needed to cultivate the lands properly and plant the palm-oil seedlings is about USD 8,000 per hectare, hence a total of USD 480 million for 60,000 ha. The five extraction mills will cost approx. USD 30 million each, or a total of USD 150 million. The cost of the refinery is set to USD 100 million, harbor construction 30 million, and roads 10 million: thus Prestige will need to invest a total of USD 770 million for the El Cimarrón plantation.

There is a technical limitation current engines cannot work properly on biodiesel with a high component of PME and other first generation products, and the EU Fuel Quality Directive limits the mixture to only 7 percent. An alternative is to convert CPO to Hydrotreated Vegetable Oil (HVO) with superior technical qualities that would allow 40 percent substitution of fossil diesel without making it a technically inferior product. The HVO conversion is a more complicated and costly process than PME production, but still technically possible in Colombia as the main input hydrogen which can be produced economically from the abundant deposits of natural gas in Los Llanos[3].

The total GHG emissions in a life-cycle analysis for biodiesel from El Cimarrón are actually negative. This seemingly impossibility is due to the fact that Prestige actually plants a (palm) forest on degrade treeless land, and this forest happen to produce biodiesel. The reforestation effect is credited to the biodiesel which furthermore implies that the carbon saving effect is

[3] We have not calculated the GHG emissions from HVO, but they are probably in line with the figures for PME

higher the less biodiesel is produced. The reforestation effect is very relevant as Forest First is planting a conventional commercial forest close by without such annual byproduct of biodiesel. The palms could similarly to the commercial forest be converted to chips for energy production after 25 years when the CPO production ends, thereby reducing the GHG emissions even more.

The calculations by Quantis International hence indicate a GHG emission reduction of 135% compared to fossil fuels when transported through Venezuela, slightly less of 126% if transported through Colombia by truck to the port of Cartagena, see figure 2 and 3 in appendix 9.14 and source Gmünder (2017). Both figures surpasses the current EU RED requirement of 60% GHG emissions reduction[4]. The direct land use effect is only valid for 20 years after planting, and then set to zero according to the EU RED methodology. The emission reduction is then reduced to 60 percent, but the consultant indicate this is a conservative estimate as it is possible to improve the management of the plantation.

3.7 Other environmental effects

GHG emissions is a major concern addressed in the twin report Gmünder (2017), but the production must also satisfy other environmental requirements to be deemed sustainable. There is probably enough water in the rivers running through the area to irrigate the plantation without affecting the water level considerably. However, there is a fear that nutrients and fertilizers will be washed into the watershed. Prestige does not apply irrigation on the current pilot plantation and does not plan to invest in such structures in this planned large scale project. The natural composting furthermore reduce fertilizer application and possible overflow of nutrients. Eutrophication is hence not a concern in this case. Prestige will also apply recommended types and amount to reduce possible ecotoxicity.

Los Llanos is famous for a rich wildlife, with many specious of birds, fish and plants in the river areas and permanent wetlands. However, the forested belt on each side of the river in the Altillanura is normally less than 50 meters. Then the degraded savannah starts with very low biodiversity. A conversion is not affecting the river area per se. Furthermore, several studies demonstrate that biodiversity actually increases when these extensive pastures are transformed

[4] Currently EU just require 35% reduction in GHG emission biofuel produced on facilities in place before 1. January 2016, but the demand increases to 50% from 1. January 2018 for the same product. All production coming on stream after 1. January 2016 (including El Cimarrón) must reduce GHG emissions by 60%. The new proposal by the European Commission is 70% GHG emissions reduction for biodiesel after 2021. The two figures are not directly comparably as the EU RED calculation methodology changes, e.g. the missions from fossil fuels as reference is set considerably higher and hence increases the reduction effect of sustainable biodiesel all else equal.

to palm plantations (Gilroy et al, 2015). Prestige will also include wildlife corridors on the plantation according to current recommendations by environmental organizations.

Large monoculture plantations of any kind are considered risky as deceases will spread fast and cause major damages to the crop with environmental consequences. Many recommend to alternate different crops to reduce this risk. Such strategy will also be considered in this project especially if requested by the government. This business plan does however not investigate the issue further since we had to limit our study to geographically defined area in order to calculate GHG emissions in the twin report by Gmünder (2017). However, due to the homogeneity of the land in the whole Altillanura region, we expect that such diversification strategy by for example expanding the area to 120.000 ha interrelating cattle, corn for food and palm for food as well as biofuels would give similar GHG emissions for the biofuel share.

4 Labor demand and CSR

4.1 Agro-industrial cluster

Palm-oil cultivation is relatively labor-intensive, as fully mechanized production farming is not feasible. Fertilizing, pruning and harvesting remains manual work, where each palm must be cared for individually. The rule of thumb in the industry is one full-time worker per 10 ha. The palm fruits are harvested continuously through the year, without significant seasonal variations. Therefore Prestige intends to offer permanent positions rather than seasonal employment, in order to train its personnel for better efficiency and accuracy.

As Los Llanos is sparely populated and it is not possible to hire enough workers locally. Current large-scale agricultural operations hire male workers from other parts of the country on time-limited contracts, normally four weeks working on the farm and then two weeks off. Many workers also come for longer periods, to save up money for specific purposes at home, e.g. building a house or setting up a small business. Such workers might stay for 6–12 months continuously, to maximize income and minimize spending.

A commuting solution will not be viable with a 60,000 ha project, so Prestige wants to establish permanent local settlements where employees can live and bring their families. The original plan was for a self-sufficient community on company premises, where families would cultivate food and deliver services in collaboration with a Colombian NGO. Planning was carried out by the renowned Norwegian architect firm Snøhetta, which specializes in greenfield urban

constructions in resource-rich developing countries (Snøhetta, 2002), and the assignment was funded by the Norwegian Agency for Development Cooperation (NORAD).

Prestige later shelved these plans, in view of the possible dependency ties between the company and the employees, as observed in other company towns across the globe. Prestige now favors an industrial cluster solution centered in the small town of Nueva Antioquia, conveniently located by the Meta River, near to the port and only 24 km from Cimarrón. Currently Prestige is constructing a 5-m broad dirt road to connect Cimarrón to Nueva Antioquia. Once farming in Los Llanos is proved profitable, the municipality of Primavera is expected to develop into a dynamic agro-industrial cluster with small urbanized settlements interconnected by roads.

This cluster idea aims to maintain the independence of employer and employees, leaving wage and working conditions to be settled by market mechanisms. If an employee is not satisfied, he can move to another employer; and if an employer needs more workers, he can attract workers from the local labor pool by offering higher wages and better working conditions.

The existence of several companies in the same area will increase demand for specialized services from independent suppliers. In turn, such supply infrastructure reduces the startup costs for new companies, promoting economic growth more broadly.

4.2 IDPs, coca growers and young households

The estimated 6,000 employees at El Cimarrón and their families will require a new urbanization area of at least 25,000 inhabitants assuming on average three members in each household, plus all the new population that will be offering services (schools, supplies, health centers, etc.) to those families. If two other local producers expand their activities to a comparable extent, the urbanization process will lead to a full-fledged city with a population of 75,000—a size sufficient to warrant the development of infrastructure and public services that would provide a good standard of living.

The challenge for Prestige and the other companies will be to attract enough workers and their families to this currently isolated area. One source of potential workers might be the estimated 6 million persons who have been internally displaced as a result of the armed conflict. They tend to be more willing to move, as they are often less integrated into the communities where they are today. The pull factor of improved standards as alternative to precarious living conditions can play a significant role. Moreover, the Vichada region was little affected by the conflict during the past five decades and represents a safe heaven.

However, it can be expected that the most of the labor force will be young people in search of professional development and better economic prospects. The peace accord will increase government control of current coca-growing regions, hastening the demise of this rather labor-intensive illegal activity (see map, Appendix 9.5). The emerging field of bio-energy agro-business can attract this new pool of rural workers who originally migrated into the coca-growing regions attracted by high-income opportunities; moreover, government programs of local coca substitution have proven rather unsuccessful as yet. The agricultural skills of these people will be appreciated, and they can expect to be well remunerated if they move to Los Llanos. As Colombian biofuels are sold with a "sustainability markup" in Europe, the sector will be able to offer potential workers higher wages, accessible housing and prospects of urban development.

However, successful development of the plantation and cluster might attract too many people in search of jobs. There is hence a risk for two-tier development in the community. On one side, the employed with relatively high wages compared to the national average; on the other, jobless people who come seeking good jobs. Prestige will actively seek collaboration with other companies in the region and with the public authorities to meet and minimize this challenge.

4.3 Corporate social responsibility

Prestige currently provides economic support to the nearby hamlet of Nueva Antioquia with about 80 houses and indigenous communities nearby, in collaboration with several cattle-ranching neighbors. One of them is Gabriel Jaramillo, who runs a modern meat production farm in line with the Brazilian cattle-raising model.[5] Prestige and Jaramillo have approached the local authorities in order to identify ways businesses can support social development in the area. One activity involves facilitating access to basic education, so that children from the indigenous reserves attend the local school in Nueva Antioquia. This was done by building a special classroom, providing indigenous food for school lunches and recruiting teachers familiar with the local indigenous language. A second project aims to provide electricity to the residents Nueva Antioquia, a need identified by the local people themselves.

These small-scale CSR initiatives reflect the hitherto small production volumes on both farms, which are still in the initial phase of operations. Full-scale development of an urban area of

[5] Gabriel Jaramillo is a Colombian citizen and former CEO of Banco Santander in Brazil, later leader of the Global Fund against Malaria in Genève. Similar to Siem, he started the cattle operation to demonstrate that modern production is profitable and can benefit the population also in such a remote region.

75,000 inhabitants will require the active involvement of government authorities at all levels. The government and the ministries have identified the Altillanura in the departments of Meta and Vichada as the main development zone for Colombian agriculture (GoC, 2014, 2016b). This should guarantee state willingness to invest limited resources and institutional capacity into developing the necessary infrastructure. Such public spending could also be funded through taxation of the companies established in the zone[6].

A less tempting alternative for the companies in the region, including Prestige, would be to coordinate their contributions to finance and organize the urban development of Nueva Antioquia. Ultimately, if there is no willingness to fund urban development, Prestige could return to the "company town" solution, which would involve meeting all needs of the workers' families on their own premises.

4.4 Employment conditions

Today, El Cimarrón has accommodation facilities for 150 workers in comfortable houses. The workers are remunerated above the standard in Vichada, about COP 1 million (USD 330) a month, compared to COP 800,000, the legal minimum wage in Colombia. Local employees tend to stay on the farm from Monday to Saturday afternoon, and then spend the remainder of the weekend with their families. Once the new dirt road is ready, Prestige will transport workers by buses to and from Nueva Antioquia on a daily basis.

4.5 Indigenous population

The department of Vichada is sparsely populated with ca. 73,000 inhabitants on 100,242 km^2 in 2016, i.e. only 0.74 persons/km^2 (projection in Dane, 2010). Indigenous people constituted 44.4% of the population in 2005. The main indigenous group in the north of Vichada are the Sikuani, who are reckoned to the Guahibo group. They live in small communities, most descending from one family, scattered over a large area with an estimated population of 23,000 in Colombia and 11,600 in Venezuela. Originally nomadic, they established permanently settlements during the last century (DNP, 2010)

[6] Urbanization is further complicated in the new Zidres law where the current local political leaders are given righto veto such industrial projects. In a Norwegian context it would seem odd to give such power to a small hamlet of 80 houses to decide large scale regional development of 75.000 inhabitants with economic impact at national level. However, we already find examples that local government has impeded the establishment of competing urbanizations and hence defacto forcing the companies to rely only on commuting workers. It is hence vital to find a collaborative understanding both with current local government as well as state agencies.

There is only one government-recognized indigenous reserve in Primavera municipality. The Campo Alegre/Ripialito reserve is rather small covering only 10 km^2, and is situated about 35 km to the west of Nueva Antioquia along Meta River (see map, Appendix 9.6). The reserve belongs to two separate Sikuani communities with an estimated 200 inhabitants each. They arrived and settled in the 1950s, according to local informants. However, there is also a third indigenous community of similar size in Laguna Grande close to the reserve. They moved from Cumaribo, 175 km to the south, about 10 years ago and settled on privately owned land which is still in dispute.[7] The government does not recognize this community's claim to this land, but has neither attempted to evict the group.

These indigenous reserves and settlements are about 10 km distant from north-western corner of the planned area in focus for this palm-oil development, and will thus remain unaffected by the project. The Office of Prior Consultations at the Colombian Ministry of the Interior issues formal certifications of indigenous rights and claims to explicitly defined areas for project development. They consult five separate public databases[8] to verify the existence, or non-existence, of indigenous groups with territorial rights in a geographically defined area as regards infrastructure, investment and commercial development projects. It is hence possible to get formal certification from the state that there are no competing claims to the planned area. In addition, Prestige itself has conducted enquiries to determine the presence of possible non-registered indigenous groups, and concludes that there is no reason to expect land claims.

Possible claims or incursions by migrant indigenous groups are unlikely, for several reasons. Indigenous groups of Los Llanos traditionally settle along the river to fish, hunt in riverbank forests and practice small-scale agriculture. However, in the event of indigenous migration into the area, it would be possible to accommodate the newcomers and welcome them as workers on the farm. The people in the three indigenous communities of Compo Alegre, Ripialito and Laguna Grande today work on a cattle farm owned by Gabriel Jaramillo, and, partly facilitated by Prestige, the children attend a local school. However, closeness to a new urban center will probably constitute a major challenge for the indigenous culture and way of life. Such territorial

[7] Local informants say one of their community married the former owner but was later divorced and died. The group hence claims rights to the land on grounds of this marriage.
[8] The five databases are (i) Directorate for indigenous affairs, ROM and minorities, (ii) Directorate for Negro communities, Afro-Colombians, Raizales and Palenqueras, (iii) Land register authority INCODER, (iv) Mapping authority IGAC and (v) Department authorities DCP.

and cultural considerations is normally a national matter and should hence be decided through normal democratic channels.

4.6 Other local population

The El Cimarrón property of 13,000 ha constitutes the core of the area in this 60,000 ha plantation development project. Prestige has uncontested property rights to the land, with registered title deeds in the Office of Registry of Public Instruments (ORIP). The planned plantation will expand into neighboring land mostly towards the Meta River to the north, through various forms of collaboration with other local rights-holders.

First, La Cabaña SAS owns the 3000 ha farm to the west and is already collaborating through an agreement for delivery of 350 ha of oil palm for processing to the expansion mill under construction at El Cimarrón. Other large-scale properties in the area have also considered joining the project.

Secondly, the land between El Cimarrón and the Meta River was originally acquired by the now-liquidated company El Toro Noreste Ltd, owned partly by the Siem brothers and other investors. It emerges that these 60,000 ha had only "possession titles": private agreements between cattle ranchers on borders between their land interests, made in the presence of a public notary who verified and certified that the agreement was correctly understood by both parties and was entered into voluntarily. However, the state land-property institutions had never issued any statement on property rights to the land, which was thus formally under state ownership. This problem of informal land rights became publicly known through the intervention of a senator in the Colombian Congress in 2013. The state has reclaimed these lands, which are now probably lost to the former possessors. Prestige still claims these 60,000 ha of property through a subsidiary company, but has currently no ongoing activity on the land. It is to be hoped that the earlier history of possession by Prestige will facilitate a rental agreement from the state in the future, particularly if a public–private partnership can be arranged under the new Zidres law.

The land under former possession might still be part of the planned 60,000 ha palm-oil plantation through various channels. In several regional plans of Los Llanos, the government has signaled interest in developing the agricultural potential (GoC, 2010, 2014). The new ZIDRES law indicates that commercial interests will be offered possibilities for leasing large land areas on 30-year contracts in distant sparsely populated areas that lack infrastructure (GoC,

2016b). Here the government's intention is to attract private equity capital to invest in much-needed infrastructure, as it would otherwise be difficult for smallholders to settle in the area.

The "integral rural reform", the first point in the peace agreement signed between the government and the Revolutionary Armed Forces of Colombia (FARC) in 2016, is aimed at distributing three million hectares of land to smallholders or landless rural dwellers (GoC, 2016a). The peace accord indicates that much of the land to be distributed by the Land Fund will consist of unused state lands (*baldíos*) close to El Cimarrón. The peace accord, like the ZIDRES law, emphasizes collaboration between smallholders and large agribusiness companies in integrated production and marketing chains. Under "contract farming" arrangements, farmers enter in an agreement to receive production inputs and technical assistance from an agribusiness company, and later sell the produced products to the company's processing plant, according to an agreed pricing formula. The former Minister of Agriculture, Carlos Murgas of Oleoflor S.A., has spearheaded such "production alliances" in which the farmers also own shares in the processing and refinery of the palm oil. Oleoflor now controls a considerable share of the Colombian market by using this strategy. It is expected that the government will distribute part of the state land in Primavera municipality for the designated project area with the request/requirement to cooperate in palm cultivation with Prestige Colombia SAS. Today there are four or five smallholder land occupants on this land that might be incorporated into a strategic alliance with Prestige Colombia SAS.

The total land area needed will be cultivated by different actors, but coordinated into one single industrial operation towards the refinery on the banks of Rio Meta and hence shipment to consumers abroad:

- Prestige's farm El Cimarrón, 13,000 ha
- other privately owned neighboring farms like La Cabaña, 8,000 ha
- Prestige-leased state land, 25,000 ha
- smallholders receiving state land for productive alliances with Prestige, 14,000 ha

The composition of the different types might change without affecting the actual design of the project. Neither would reformulation of the project-designated area—for example, by excluding neighbors or smallholders uninterested in collaborating, and including instead other willing partners—dramatically change the viability the project. It would only imply marginally higher transport costs from the field to the extraction mills.

5 Indirect effects on environment and food consumption

5.1 Increase world food supply

Most crops grown on agricultural land can be used as food or converted to biofuels. Producing biofuels from existing crops reduces the food supply accordingly. However, much potential cropland is not farmed, because of its low profitability. By allowing the conversion to biofuels, idle land can be put to use, unlocking its economic potential. The EU has as yet no certification system for evaluating such indirect effects. The so-called iLUC directive in EU amends both the EU RED and EU Fuel quality directive by implicitly reducing the possible migration of food production to forested areas by limiting the use of biodiesel from foods to 7 percent of all energy used in transport[9] (EU, 2015). The European Commission wants to reduce this figure further in a proposed amendment to the EU RED (EC, 2016a). They also propose to penalize all biofuel production on farmland adding standardized CO2 equivalents iLUC factor for all oil crops established on pre-existing agricultural farm land. This does not apply to El Cimarrón as the new plantation takes place on 'grasslands' explicitly exempted in the appendix of the proposal (EC, 2016b).

Furthermore, palm oil for sustainable biodiesel can later be sold as food when relative market prices change or if policy-makers impose such use by fiat. This flexibility means that conventional biofuel production today, aimed at immediate reduction in GHG emissions, can be used for sales to food markets.

Most of the land in Los Llanos, particularly in Vichada, is not farmed today. A century of extensive cattle ranching on the natural savannas has left the land degraded even if the herds are small with as little as one head of cattle per 100 ha[10]. These lands can in practice be considered as idle, and any greenfield investment in modern agricultural production facilities will improve the land, without ousting other crops. The byproduct kernel meal from the palm

[9] This includes trains, ships, etc. and is not comparable with the Norwegian regulations that implicitly accepts 12% conventional biofuels in road traffic.

[10] The soil in the Altillanura has a very low soil organic content and consists mainly of grasslands. There is an ongoing discussion on the historic reason and thereby the classification. We chose the term "degraded lands" for Vichada in accordance with the way the World Bank defines Vichada. Concretely it has 8.1 MT of soil organic matter per hectare in our baseline calculation in the twin GHG emission report (Gmünder, 2017). It is probably close to natural savannah as extensive cattle herding and fires to renew the grass has only reduced the fertility marginally. It is hence not "degraded pastures" which in some multilateral programs and agreements is entitled to support of various kinds and double counting in EU RED. Regeneration of land that has lost fertility is of some unknown reason considered to be more valuable than to increase fertility of land that has a low soil organic content naturally.

oil production is used as animal fodder and will probably induce more meet production than is currently produced on the same land. More importantly, low prices on food products that Colombia imports will probably prevent alternative uses of the land since the operation will not be profitable. Only the willingness to pay for sustainable biodiesel will give sufficient income to tempt anyone to start large scale industrial agricultural development in Vichada.

The EU RED stipulates that biofuel production must not lead to local food shortages, as discussed above. This does not constitute a problem in Los Llanos, where there is hardly any food production or population. However, activists, scientists and politicians are also concerned about global food supply in the long run: world population continues to increase and there is only a limited amount of fertile agricultural land. Today, undernutrition is more the result of economic inequality and weak institutions than of the potential for food production. Greenfield biofuel production in Los Llanos would not reduce current food supply, as the land would otherwise be idle. In fact, it would increases the future supply to the food market, for four reasons. One, only a simple decision is needed for the product to be sold as food instead of being converted to biofuels. Two, the oil palms serve to rehabilitate the degraded land into fertile lands by improving the structure of the soil and increasing its nutrient content. In the future, uprooting palms to be replaced by other food crops would bring higher crop yields, compared to sowing directly on the current degraded land. As the lifecycle of oil palms is normally 25 to 30 years, it will be natural to decide how to exploit the land again in 2050, by which time world population is projected to 9.7 billion, 11.2 billion people by 2100 (UN, 2015). Three,

EU RED is more concerned about local food shortages, as powerholders might convert existing crops or agricultural land to biofuel production, without regard for the consequences for their own citizens.

5.2 Climate effects of using degraded land

The EU-RED only require biofuels to reduce emissions by 60% compared to fossil fuels; there are no explicit requirements as to how or where it is to be produced. Import from non-EU members will be possible, as biofuels are traded, like other goods and services, in line with existing trade agreements. In practice, however, some member countries might seek to restrict sourcing of sustainable biofuels to national companies and/or farmers. Furthermore, they might support the development of new technology that uses non-food products as input to the biodiesel

production in order to create national workplaces and give national companies a head start in the global competition within this new economic sector. One example is the government decision in Norway to increase the biofuel mixture to 20% by 2020, of which 8% must be "advanced biofuels," defined as waste/residuals or forest raw material. This is intended to promote technological progress that will make it possible to produce price-competitive sustainable energy from non-foods in the future. EU RED still incentivizes advanced biofuels through "double counting", e.g. one liter equals two liters of conventional fuel in the accounting of the 10% requirement.

Increased supply of easily tradable sustainable biodiesel from Los Llanos might affect supply and demand in other regions and countries through the price mechanism, thereby affecting world food production and GHG emissions. Furthermore, the supply of sustainable biofuels influences consumer, voter and politician perceptions and expectations about the future, and hence behavior and decision-making today. Consideration must be given to how this will affect government politics, taxation and subsidies as well as investment and technology development. Comparison of the two scenarios of purchase or no purchase of sustainable conventional biofuels produced in Colombia and other non-EU countries is possible only in a macro-economic equilibrium model with detailed food and energy sectors. Together with a team of economists, political scientists, and biologists, this author has developed a research proposal for analyzing these equilibrium effects in a special version of the Global Trade Analysis Project (GTAP). The project description foresees the following partial effect outcomes:

Substitution effect: The increased supply of sustainable energy from greenfield production of palm oil in Colombia induces a negative shift in demand for unsustainable energy types, replacing fossil fuels and other biofuels from rainforest. However, it might also replace other types of sustainable energy through lowering the marked price. Land currently used for conventional biofuels of less productive crops, e.g. rapeseed, soy and others, will be converted to food crop production. There will also be less pressure to expand the agricultural frontier into rainforest areas for both food production and biofuel production. Even reforestation of crop land could be the effect if the marked prices decreases sufficiently.

Scale effect: Increased supply from greenfield production will lead to lower energy prices compared to the counterfactual of no increase in supply. Lower prices lead to higher energy consumption, everything else being equal. Similarly, if biofuels promote new infrastructure and the development of an agricultural supply industry in Los Llanos, lower costs will also lead to

additional food production, by including even more degraded land into modern high-yield. The palm oil has a yield much higher than any other vegetable oil crop—with 3.74 mt oil/ha, trailed by rapeseed, which has less than 1/6 of that yield (see Figure 1, Appendix 9.12). If palm oil can outcompete these crops, much agricultural land will be freed for other purposes, whether more food production or restoration to its natural state.

Technology effects: New technologies for alternative sustainable energies hinge on expectations as to future demand and prices. The sector today is heavily subsidized by governments, as private actors are not willing to carry the risks. Such government involvement weakens the link between future prices and current investment, as the state can continue to invest in new technologies, knowing it will be able to regulate energy consumption once a sustainable price-competitive solution is found. Equally, private companies will be willing to invest in new advanced technology foreseeing government regulation once they become competitive with conventional technology.

Increased supply of sustainable biodiesel from palm oil can be expected to lead to innovations that may make sustainable as well as unsustainable products more competitive compared to other types of energy—for instance, greater combustion-engine efficiency. We can hence expect that demand also for the unsustainable types will increase in the future, but the effect is likely to be rather small in absolute terms. Furthermore, higher efficiency will reduce the overall need for energy and hence also reduce the demand for all palm oil.

Further, NGOs perceive two risks related to the expected behavior of consumer and politicians. First, they do not believe the public is able to distinguish between sustainably and unsustainably produced palm oil. Supply of the former will hence also increase demand for the latter. The only way to avoid unsustainable palm is to ban all palm. Second, palm as such is demonized in the public. Even a minor amounts of sustainable palm could infect all biodiesel, conventional and advanced alike, with the same bad reputation leading to consumer boycott.

Both challenges require that all actors do their uttermost to educate the public of the difference between sustainable and unsustainable palm. This dilemma exemplifies how simplifications and generalizations in the environmental debate might backfire in the long run and prevent the development towards a more climate friendly society.

A seeming, but at a closer look not relevant, parallel example of the first risk is the market for elephant and rhinoceros ivory. The supply of certified tusks for overpopulated areas of Africa

also increases demand for uncertified tusks in Asia (Fischer, 2004). However, this is probably because consumers can now pretend that the illegal ivory is legal, to avoid social sanctions—after all, there is no apparent physical difference. Consumption of palm oil is different: consumption as such is not evident to outside observers, so personal feelings of remorse and self-criticism on the part of the consumer is the only sanction possible. With palm oil, thus, there is no reason to believe the supply of certified products will increase the demand for uncertified products. Indeed, the converse: as consumers with bad consciences for buying uncertified products can now finally buy certified products instead, with a clear conscience.

The political regulation of the current and future energy markets ultimately depends on the will and perceptions of members of the general public, as demonstrated in elections or influence on politicians through other channels. Those critical to conventional biofuels, as well as to carbon capture and storage (CCS), indicate that these will be perceived as simple solutions to the climate problem and hence make it possible to continue current lifestyles without major adaptations. In their view, today's high consumption rates are not sustainable in the long run, also for other reasons not related to GHG emissions, so introducing biofuels means losing an opportunity to convince people to opt for less materialistic and consume-oriented lifestyle. However, given the current political equilibria, a dramatic increase in energy prices is unlikely to be tolerated by the public. A politically viable solution in the short and medium term is the use of conventional biofuels until more advanced alternatives not requiring agricultural lands become reasonably price-competitive. When that time comes, a radical change can take place through regulations without causing political uproar.

The aggregated total effect of adding greenfield-sustainable biofuel projects on degraded land is expected to be positive to the climate as well as to food production, given the magnitude of the initial positive substitution effect.

The oil palm is today the major source of vegetable oil with 38.8% of world production in 2015/2016, see table in Appendix 9.7 (USDA, 2016), surpassing soy bean by nearly 10 percentage points. Main producer countries are Malaysia and Indonesia, with 90–95% of world production. Oil- palm plantations are established mostly on what are seen as marginal lands in rainforests and marsh, as more productive land suitable for agriculture is used for essential food production. The oil palm thrives in such "marginal" lands and has hence become synonymous with rain forest destruction. Expansion is now occurring in Borneo, in the Indonesian and the Papua New Guinea parts of the island where there is still virgin rainforest. The palm oil

plantation is also expanding in Africa—on natural savannas, but also considerably within the Congo rainforest basin and in the rainforests of Western Africa. A projected increase in palm-oil production can be expected, as many countries are requiring biofuels to be mixed into their fuels; and food consumption is rising as the populations enter the middle-income bracket.

There are degraded land suitable for palm-oil production not only in Los Llanos of Colombia and Venezuela, but also in the state of Para in Brazil and parts of Indonesia. The homogeneous large area of degraded land in Los Llanos gives Colombia a comparative advantage, as it will be easier to certify that the exported product is 100% sustainably produced. It is difficult to mix in non-sustainable palm oil, as the rainforests in question are very distant, making it costly to commit fraud by blending the two types. Furthermore, with large-volume greenfield plantations in a restricted geographical area it will be easier to impose an efficient certification system and reliable control mechanisms by independent institutions, right from the start. There are no heavy vested interests in palm-oil production in Colombia, so the government can be expected to be less lenient on shortcomings in the industry, and demand efficiency and sustainable production.

The African palm has been widely demonized by NGOs and other producers. Its main "crime" is to be too efficient and thrifty. It produces about ten times as much oil per hectare compared to other vegetable oils, requiring just the same amount of energy as sugarcane for methanol production, which has been considered the most efficient crop in the world. Furthermore, oil palm thrives on soils that are too depleted or have unsuitable texture for other crops. The problem is not the oil palm, but human beings, when they establish plantations of African palm that crowed out agricultural production and virgin jungle. With urbanization and the need for industrial quantities, large private cooperation with ties to politics have become the main culprits. On the other hand, the massive need for labor makes the sector a major employer in the countryside, enabling people to earn a decent livelihood—and making it very difficult for national governments to halt the expansion into rainforests by force. What might prove more effective is implicit regulation by promoting alternative expansion into sustainable agricultural lands.

There might be an indirect land-use effect of starting greenfield production in Los Llanos, through the markets. Increased supply of sustainable palm oil can reduce the need to use agricultural land for biofuels production elsewhere. It can replace less land-efficient rapeseed and other vegetable oils also used in the biofuel industry, freeing food-crop land for other types of production. If the biofuel industry can also promote the use of palm oil for the food market,

consumers might switch away from unsustainable production, reducing rainforest depletion: fewer new plantations will be needed to satisfy food demand.

On the other hand, any increase in supply will lead to relatively lower prices and hence higher consumption of both energy and food. However, this should not only negative as we should also appreciate the general welfare effect. A major share of the world population lives in poverty, so improving their living conditions should be recognized as an important aspect.

5.3 Environmental effects

There are important substitution effects within Colombia itself. Palm-oil cultivation in the Choco rainforest has become less lucrative; moreover, some plantations have been abandoned because of lawless conditions in the area. Peace might reverse this trend, as poor people and well as companies can now enter areas formerly controlled by the FARC without fearing violence and extortion by illegal organizations. By opening for alternative migration to Los Llanos will it be possible prevent them from entering the rainforest.

Large international food companies will be able to exchange an unsustainable product for a sustainable one. The loss of markets will force leading exporters of unsustainable products to change their strategies in order to meet the challenge from exporters of sustainable products—for example in Indonesia, where the estimate of "degraded" lands range from 4.7 million ha "very critical" to 19.6 million ha "critical" (MoEF, 2014)

6 Challenges

6.1 Transport

River transport depends on government institutions to keep transport routes open, physically and institutionally. Especially the Meta River has problems with rising/falling water levels that move loose sediments in the river bed and change transport routes. The Colombian government has conducted several studies on improving the viability of river transport and developing the Orinoco region (GoC, 2015a). However, estimated investment costs are high and implementation will require political commitment that has not yet been evident. This might change now, with the peace agreement between the government and the FARC guerilla. Effective state presence and territorial control can secure private and public investments, and, with investors recognizing the improved security and stability conditions for doing business in the country, Colombian products can reach global markets and attract foreign capital.

An additional challenge concerns overcoming discretionary institutional and informal interventions during transport through Venezuela on the Orinoco River. There is some transport on the river today, but it could become easier with international pressure to secure open transport routes. Institutional changes can be expected in Venezuela before the El Cimarrón project is ready to export due to upcoming elections in 2018.

6.2 History of land rights in Colombia

Much of the land in Colombia is not properly titled and registered. The new land titling agency has estimated 2.5 million plots of land in need of formalization, but no areal estimates exist (Universal, 2016) In Colombia, people have generally acquired land rights through use. Farming idle state land for five years[11] in good faith or 10 years in bad faith (e.g. the farmer is told to leave but is not evicted) gives a farmer the right to formalize the property into full-fledged private property. On private property, a similar right can be claimed after 10 years' occupancy in good faith and 20 years in bad faith.[12] Another important requirement is that 2/3 of the claimed land must have been utilized and developed for farming.

In 1961 Colombia introduced a land reform whereby each beneficiary would be granted one household agrarian unit (UAF). One UAF corresponds to the area of land sufficient for one household to make a decent living; it therefore differs in size depending on soil fertility and climate conditions—varying from 20 ha on prime agricultural land to 3000 ha for extensive cattle herding in some parts of Los Llanos. Once the use of state land has been demonstrated, small-scale farmers may demand written adjudication of user rights from the Colombian Institute of Agrarian Reform (INCORA)[13] which they may bring to the Public Registry (ORIP) in order to get a proper land-title deed issued and registered. The small-scale farmer would then be free to sell the land after a certain time had elapsed. According to the law, farmers should first offer the land to INCORA. If INCORA was not interested, they could sell to anyone. Restrictions on not holding more than the UAF would still apply.

[11] https://www.sivirtual.gov.co/8/-/tramite/T8615

[12] Law 1448/2011 introduces the Colombian land restitution program to help internally displaced people return to lost or abandoned land during the violent conflict. However, the cutoff date for making land restitution claim was set to 1991 since even violent dispossessions earlier would be considered legal property of the perpetrator according to the law (Garcia-Godos & Wiig, 2014)

[13] The faculties of INCORA were transferred to the new Colombian Institute of Rural Development (INCODER) in 2003. The President closed INCODER in 2015 and distributed its tasks to several new entities in order to improve efficiency: Agencia Nacional de Tierras, Agencia de Desarrollo Rural, Agencia para la Renovación del Territorio, Consejo Superior de Uso del Suelo, Consejo Superior de Restitución de Tierras, la Dirección de Mujer Rural in el Ministerio de Agricultura. The government furthermore increased the Budget for Fondo de Microfinanzas Rurales and strengthened Comisión Nacional de Crédito Agropecuario, amongst others.

There are three major sources of informality in the Colombian land system. First, the sale of registered property rights does not have to be reported to ORIP or any other state land institutions in order to be considered a legally valid transaction. Only verification by a public notary has been the norm, so the land registry is often not updated by those involved in the transaction. Second, untitled lands "carry no history" in Colombian law. It is not possible to transfer existing rights to land acquired through adjudicated or possession. However, it is possible to buy and sell the right to "improvements" that are very difficult to separate from the land itself, like land clearance, soil management, standing perennial crops, fences, housing, etc. Third, individuals can enter into private agreements on actions normally verified by a public notary, e.g. on respect for borders that divide land owed and used by different cattle herders. These "certifications of possession" were until recently often accepted as an equivalent to property title deeds— banks were willing to issue loans, and the government to pay subsidies, accepting such certificates as collateral. These rights are no longer acknowledged: instead, the government reclaims such land as idle state lands.

The revision of the land reform law through Law 160 of 1994 restricted the right to sell land. It became illegal to merge plots of land that originated from adjudication of idle state lands if that would result in the buyer will control more than one agricultural unit (UAF). This limitation has become a *de facto* prohibition of industrial agriculture, which requires larger units to be technically efficient. Companies and agricultural entrepreneurs have evaded the problem in various ways. They may simply buy several properties, hoping that the state will never decide to intervene. Or, they may create several shelf companies where each buys just one property, but all are farmed as one unit (Oxfam, 2013). In addition, the original adjudication may be fraudulently certified to intermediaries who did not fulfill the requirements due to corruption, cohesion or simply incompetence in INCORA. Since 1994 and until today, Colombian judges have not accepted mergers of such properties beyond the UAF limit. However, the industry and the Ministry of Agriculture argue that the law cannot be applied retroactively to lands adjudicated prior to 1994. President Santos shares this perspective, as the 2016 ZIDRES law[14]

[14] Law 1776 of 2016 (the ZIDRES law), states that agricultural industrial zones can be declared only if (i) isolated from urban centers (ii) needs of high investment in land development to make it productive (iii) low population density and (iv) high poverty rates or lack roads for transport of products to the market. Additional specifications later provided in Decree 1276 of 2016 require land not to be in (i) indigenous reserves (ii) ethnic communities (iii) Peasant Reserve Zones (iv) Afro-Colombian regions with collective property rights and (v) territories with high environmental significance like natural parks, highland and wetlands (GoC, 2016b). Duarte (2016) considers Vichada in general as a major potential, and especially the designated area of the El Cimarrón project, see Appendix 9.10.

states that owners of land that originates from adjudication after the introduction of Law 160 of 1994 exceeding one UAF are not allowed to launch production projects within a ZIDRES (GoC, 2016b). In March the same year. academics, politicians and activists immediately filed complaints, holding the ZIDRES law to be unconstitutional.[15] The Constitutional Court accepted the law in February 2017 with some changes, e.g. associative production is not obligatory which implies agribusiness can cultivate large plantations, and gives the local authorities the right veto any such production. Explicit regulation of the law will now be developed by the ministries. It is hence still unsure how long it will take before the actual large scale production can start.

The content of the peace agreement between FARC and the Colombian government is to be implemented by new laws and amendments to the Constitution, to be enacted by the Congress. The changes started as soon as the Constitutional Court has allowed the fast-track arrangements introduced for implementation of the peace agreement (Tiempo, 2016). Some 3 million ha of land will be distributed among rural households with little or no land, and 7 million ha of land currently used by smallholders will be formally titled. Once a functional titling agency is established it is also likely that land property rights on large estates will be clarified once and for all, further speeding up the land restitution process.[16] Whatever the specific outcomes, final clarification of property rights will in itself make it easier for agribusiness to accommodate accordingly, by keeping or acquiring land that will be accepted as collateral by the financing institutions.

Further, the peace agreement encourages the parties to cooperate and join agro-industrial operations through forms of "production alliance," i.e. contract farming with inputs from and sales to an industrial agriculture processing plant and operation (GoC, 2016a). The parallel legal processes and the creation of related institutions by the ZIDRES, the peace agreement and the land restitution program can jointly constitute the foundations for large-scale development of industrial agriculture in Los Llanos.

[15] Senators, academics and several leaders of peasant organizations have filed separate suits against the ZIDRES law, on two grounds: There is no consultation process in the definition of the agricultural industrial zones and the state land should benefit only small-scale farmers according to existing laws (Pilar Peña Huerta & Alvarez Morales, 2016; Robledo Castillo, Riveros, Maya, Talero, & Castillo, 2016).

[16] Such restitution claims might come in the future, hence making investment in land risky. This insecurity was partly to blame for the failure of integrated diary production in Montes de Maria on the Caribbean coast, see García Reyes & Wiig, 2017.

6.3 Secure property rights on El Cimarrón

Despite the informality of the Colombian land system, there are large areas where property rights have been clarified and are undisputed, with almost full tenure security. One such example is Prestige's El Cimarron, with 13,000 ha of titled land in Vichada. The property consists of what were originally four plots of land[17] adjudicated by INCORA to four different individuals in 1990. These were formally registered with title in ORIP in 1996 in the names of the original owners, and were purchased by the now-liquidated El Toro Noreste Ltd in 1997. The implicit merger should have been defined as illegal according to the current interpretation of the law by the Colombia court system, but as legal according to the agribusiness interpretation and the new ZIDRES law. However, it's irrelevant in this explicit case, as the four properties were handed over to the National Direction of Tax and Trade Tariffs to settle the debts of El Toro Noreste Ltd. This state agency later sold all four properties as one single bid in a public auction to the Siem brothers through their company Prestige Colombia SAS, thereby acknowledging the legality of the merger of all four farms into the one production unit now known as El Cimarrón and consisting of 13,000 ha.

There are no pending land restitution claims on El Cimarrón in La Primavera. In fact, La Primavera municipality was never deeply affected by the conflict, because of the low population density and little interest in the land by the warring parties. As yet there have been no registered claims for land restitution in this municipality at all. Further, Prestige has investigated whether any of the known original owners or descendants might have rightful claims, and found only confirmation that the transactions were voluntary and not related to the armed conflict which affected other parts of the country. If any such restitution claims would surprisingly come in the future, will Prestige prove they bought the land in good faith and thereby be more difficult to evict.

The 13,000 ha property still constitutes only a minor portion of the envisaged 60,000 ha plantation project. Prestige will investigate the legality of property rights for neighboring properties before inviting them to join the project. Prestige will also secure user rights from the government for the whole area before investments start. Renting idle state land from

[17] The properties El Cimarrón, La Diana, San Fernando, San Diego are now defacto merged and denominated El Cimarrón.

government should not entail any insecurity regarding the rights of users on 30-year leasing contracts.

El Toro Noreste Ltd also bought "certifications of possession" to another 60,000 ha of idle state lands adjacent to the current property, see Appendix 9.8. The Colombian government has reclaimed this land, as it had never been officially transferred from the state. However, the "certifications of possession" now belong to Prestige Real Estate SA, a sister company of Prestige Colombia SA, which has entered a judicial claim to the land. Some individuals still claim to be settlers on part of this disputed land, despite a court eviction order; after 20 years, they might be entitled to this disputed portion as "possessors in bad faith" according to the law.[18]

6.4 Financing of investments

The commercial risk of investing the necessary capital is considered low, given long-term sales contracts of product and government guarantee of land-user rights. That should mean that it will be possible to get moderately priced long-term funding by international capital. Prestige is currently starting negotiations on loans and support with the Inter-American Investment Cooperation (IIC), the financial wing of the Inter-American Development Bank (IDB). IDB signals that the project is large enough to be of interest as a development project. IDB only require long-term contracts for sales of product and sufficiently proven security of land tenure.

6.5 Political risks

As always in Latin America, there is the political risk that new governments might not honor former agreements, but impose different policies. However, Colombia has always been amongst the most market-friendly and open economies of the continent. Colombia is a member of the Pacific Alliance (with Mexico, Peru and Chile), a regional free-market integration initiative based on liberal market economy principles. Further, Colombia has applied for OECD membership; negotiations are expected to start once the peace agreement is implemented. The leadership of President Santos is firmly committed to developing a modern state with reliable

[18] The government started to investigate the legality of "certifications of possession" after Prestige reported to the authorities that Senator Merheg had invited middlemen and friends, supposedly poor landless people, to settle on land under Prestige's "certificate of possession." Disclosure of the senator's dubious actions brought a nationwide scandal and Merheg later fled the country (Tiempo, 2008).

institutions—a guarantee for the political and institutional stability necessary for long-term investment like the El Cimarrón project.

7 Capability and support

7.1 Innovative investors

Brothers Ole Martin and Kristian Siem own 100% of Prestige Colombia SAS and the associated processing company Extractora Cimarrón SAS. They entered the agricultural business sector in Colombia in 2001 when they were invited by the former owners of El Cimarrón to become shareholders. They have withstood various difficulties and are now ready to expand their activities to become large-scale exporters of sustainable biofuels and CPO to the world market.

Ole Martin Siem started his career in agribusiness when he bought about 3,000 ha of idle land in Portugal in 1987 at a time when the central planning economic experiment of the Portuguese government was failing. He realized that EU membership would provide Portugal with access to the enormous Internal Market. His company Frupor S.A. soon became a success with exports across Europe, now dominating the trade in Chinese leaf (cabbages), decorative foliage and carrots. Land prices increased as neighbors copied the strategy and started to invest in their own land, thereby initiating a dynamic agricultural cluster (see satellite photos in Appendix 9.13). Today Frupor employs 230 people in the peak season, and is expanding into wine and rural tourism. His brother Kristian Siem is shareholder and Director of the Board.

The two saw a clear parallel to Portugal in Los Llanos. Land prices were low; the land was fertile, well-watered and with optimal climate conditions. Easy access to the international market through the Meta and Orinoco Rivers would secure offtake of large quantities of specialized products from mechanized production. Bringing in know-how and managerial capacity would open the region and bring prosperity. Both the Colombian and Norwegian governments signaled support to the initial investment for developmental and peacebuilding reasons during the failed 1999-2002 peace negotiation, but financial support never materialized. However, the Colombian investment did not prove as profitable as expected, due to the violent conflict and loss of property rights as explained in the previous section. However, the brothers felt that such basics as fertile lands, good climate, ample water supplies and easy transport would sooner or later result in a prosperous business. The new focus on sustainable biofuels to reduce global heating seems set to prove them right.

In addition to agribusiness, the Siem brothers have a long track record of innovative and successful business development within the oil sector and shipping. They headed a group of investors that bought the Norwegian Cruise Line (NCL) when it was near to failure, turning it around and selling it in 2001 at a sizeable profit. Their family holding company Siem Industries today controls the leading companies in the sector like Subsea7, specializing in seafloor installations on deep waters in Norway and Brazil; Siem Offshore, oil service in around the world; Siem Shipping, running refrigerated vessels mainly for banana transport; and Car Carriers as well as a range of smaller companies.

The Siem brothers' excellent record of innovative industrial, financial and managerial capacity demonstrates their ability to build world-leading companies when the market and political opportunities appear. The combination of peace and institutional security in Colombia on the one hand, and the rise in world demand for biofuels on the other, represent a new opportunity for them to combine their insights on industrial development within energy and agricultural sectors. They could turn Los Llanos into an agro-industrial cluster just as they did in Portugal.

7.2 Certification

Products from El Cimarrón will be certified for environmental and social sustainability. Specifically, the EU RED holds that biodiesel from palm oil is to be defined as a sustainable product that count towards the goal of achieving 10% sustainable renewable energy within the transport sector. As explained above, the main criteria are (i) life-cycle GHG emissions at least 60% less than for fossil fuels; (ii) no farming on land with high biodiversity or carbon stock; (iii) other environmental criteria; and (iv) social criteria like labor conditions, indigenous rights, and that the activity does not reduce supply to the local food market.

Supplier companies must voluntary submit to control schemes by one of 19 accepted independent certification companies and organizations[19] (EU, 2017). The most relevant and easily applicable for Prestige on El Cimarrón products is the Roundtable of Sustainable Palm

[19] 1. ISCC (International Sustainability and Carbon Certification), 2. Bonsucro EU, 3. RTRS EU RED (Round Table on Responsible Soy EU RED), 4. RSB EU RED (Roundtable of Sustainable Biofuels EU RED), 5. 2BSvs (Biomass Biofuels voluntary scheme), 6. RBSA (Abengoa RED Bioenergy Sustainability Assurance), 7. Greenergy (Greenergy Brazilian Bioethanol verification programme), 8. Ensus voluntary scheme under RED for Ensus bioethanol production, 9. Red Tractor (Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme), 10. SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), 11. Red Cert, 12. NTA 8080, 13. RSPO RED (Roundtable on Sustainable Palm Oil RED), 14. Biograce GHG calculation tool, 15. HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels, 16. Gafta Trade Assurance Scheme, 17. KZR INIG System, 18. Trade Assurance Scheme for Combinable Crops, 19. Universal Feed Assurance Scheme.

Oil (RSPO) certification scheme. This involves the basic RSPO sustainability certification that has both environmental and social requirements which differ slightly from country to country. The Colombian RSPO national task force's interpretation of the RSPO 2013 principles and criteria was accepted by the RSPO board in 2016 (RSPO, 2013, 2016). Several Colombian palm-oil producers already have RSPO certification. However, this does not include explicit measurement of GHG emissions. Therefore, the RSPO has formulated an explicit certification scheme that satisfies the EU RED requirements (EU, 2012; RSPO, 2012). However, the organization is reluctant to actually do certification in Colombia due to lack of experience, while ISCC is willing to start this effort on the Prestige pilot plantation. Lange & Suarez (2013), document that most land in Altillanura comply with the 60% GHG reduction requirement, see map in Appendix 9.9.

NGOs and activists have criticized RSPO certification for having overly lenient requirements, insufficient control, and even being coopted by the industry (EIA, 2015; Howard, 2015). Therefore, some NGOs and industry have established an alternative certification scheme, the Palm Oil Innovation Group (POIG) calling for stronger action to tackle deforestation and human rights violations within the industry, based on more and better cooperation with local communities (POIG, 2013, 2016).[20] However, actual control of compliance with the POIG Charter indicators will be conducted by independent commercial auditors and might hence still be suspected of being too dependent on the customers. Prestige will work with auditor companies that have proven both competence and independence historically.

Also, Norwegian NGOs like the Rainforest Foundation Norway (RFN) have endorsed POIG and will accept palm oil produced for the food market under this certification scheme as sustainable. This constitutes a breakthrough, as RFN has otherwise been pressuring major food industry companies to avoid all palm oil in their products. Prestige will seek to acquire POIG certification in addition to RSPO in order to satisfy higher standards. However, RFN as well as their collaboration partner Zero, have signaled that they do not recommend biodiesel from sustainable palm oil as they fear such will also increase the demand for unsustainable palm oil.

The environment and climate NGO Bellona respected for their advanced level of technological knowhow is positive to the idea of planting oil palm on degraded lands to produce biodiesel,

[20] The companies are Agropalma, Daabon, Boulders Brands, Danone and Ferrero. The NGOs are Forests People program, Greenpeace, ILRF, Musim Mas, Orangutan land trust, Rainforest action network, Stephenson personal care, Verité, WWF, Sumatra orangutan society and Wetlands international.

but has currently no capacity to make independent investigation into this explicit project. They contribute to a land rehabilitating program in Jordan, and sees a clear parallel in our project in Los Llanos, and would like to collaborate with this author in a research financed academic projects[21].

7.3 Political support

Support for imports of biodiesel from sustainably produced oil palm in Colombia can be expected from most state institutions and environmental activists in Norway, Europe and Colombia, for various reasons:

Norway needs more biofuels to satisfy the new 20% blending requirements in the transport sector by 2020. The alternative is to extract biofuels from wood in advanced biofuels. Such strategy is physically feasible,[22] but the true monetary cost and environmental degradation are probably very high and hence not a viable option for covering all biofuel needs from the country's forest resources.

Norway furthermore supports the peace process in Colombia and has been the main facilitator for the peace negotiations between the FARC guerrilla and the government. Long-term sales contracts of export to Europe will lead to rural development and a deepening of the peace process. Whether the Norwegian Ministry of Foreign Affairs (MFA) and the Embassy will actively support long-term trade agreements and sales contracts will probably depend on the political equilibrium in Colombia. At present, some Colombian NGOs and activists have opposed the development of industrial agriculture in Los Llanos, but the public in general is perceived to be positive to such initiatives.

Furthermore, Norway's International Climate and Forest Initiative (NICFI) under the Norwegian government supports Colombia in saving its tropical forests through a multilateral

[21] The author, in his position as researcher of Oslo and Akershus University College of Applied Science, is today developing a research proposal for the Norwegian Research Council in collaboration with the Center for studies of the Orinoco region at the University of Los Andes in Colombia.

[22] Norway today extracts 10 million m^3 of timber from forests per year, or an equivalent of 16 million m^3 biomass if roots, branches and residuals are included. The estimated gross annual growth is 40 million m^3 biomass, hence another 24 million m^3 could be extracted to produce biofuels and still keep the overall status quo of the forests. The forest could also become more productive through planting last and most productive embryos, that would give faster reforestation and more dense forests compared to reproduction through natural process of seeds spread through the wind. Such changes would double the productivity to 80 million m^3. It will be possible to extract about 130 liters of biofuels per m^3 (Melbye & Holm, 2016). The potential supply of biofuels within the current forest management system is hence 3.1 bill. liter biofuels, or about 1/3 of Norwegian 9 billion liter sales of all types of petroleum products and more than total diesel consumption (SSB, 2016).

donor program managed by the Inter-American Development Bank (IDB). Norway will pay a maximum of NOK 1.8 bill. upon proven results by 2020. Norway could alleviate the pressure of expanding agriculture into rainforests by supporting programs on the degraded land of Los Llanos. As explained above, the expected increase in associated food production would also reduce the need for production in rainforests. With the peace agreement, the threat to the rainforests has in fact become aggravated: he absence of political violence and illegal armed actors makes it less risky for small-scale farmers and commercial interests to enter the rainforests. Both NICFI and the MFA are concerned about the potential unintended negative effects of the peace. The current cooperation agreement between Norway and Colombia includes zonification of at least 750,000 ha for agricultural purposes in the Orinoco region, signaling a focus on planning the agricultural expansion in an environmentally friendly way, and Norway's intent to support the planning and development of this region (NICFI, 2015).

Further, it is important to create alternative sources of income for the rural inhabitants who have been cultivating coca leaves. The peace agreement has launched the substitution of crops on the same land, e.g. convincing the farmers to grow coffee, cocoa and other food crops instead of coca leaves. However, previous substitution policies have failed (Strang et al., 2012). One reason is that the cartels controlling the coca trade are willing to pay the farmers more to continue growing coca when alternative income sources increase. An alternative is to develop cultivations with high income potential somewhere else, e.g. palm oil in Los Llanos. Many families moved to coca producing areas in search of a higher income not so long ago. These families might be interested in starting anew in other regions, producing legal crops. The eradication of coca production is widely recognized as necessary to secure lasting peace in Colombia. The Norwegian, Colombian and not at least US authorities would probably support efforts to provide alternative rural incomes for former coca-farmers.

The Colombian government considers Los Llanos to be the country's untapped land resource, one to be made productive through appropriate technology and investments. Here we can note a recent parallel from Brazil, where a remarkable reduction in the deforestation of the Brazilian Amazon took place at the same time as Brazilian farmers started to cultivate the El Cerrado area. Moreover, the climatic conditions in Los Llanos are better suited for the African palm than are the more humid areas in the rainforests of Choco and the Amazon, where legal and illegal plantations alike are heavily disease-infested. The focus of the current Colombian development plan is agriculture and tourism for Los Llanos, with the goal of protecting valuable

high-diversity areas (GoC, 2014, 2015b). Investments in public infrastructure would facilitate the process, but large-scale agriculture businesses could still develop production without government investments. The ZIDRES law designates only industrial agricultural zones in depopulated regions where small-scale farming is not considered a viable alternative and there is a need for large-scale investment (GoC, 2016b).

7.4 Climate coalition to support imports

Biodiesel from imported palm oil is likely to be legally permitted. However, it will also require political acceptance and public support, because of the stigma currently attached to palm oil in Europe and not least in Norway.

All political parties on Norway support, to varying degrees, measures against global warming, and are now searching for solutions to comply with Norwegian commitments under the COP21 and EU RED. Only a minority within right-wing The Progress Party (FrP) are "climate sceptics". However, Norwegian politicians may prefer to develop advanced biofuel technology in Norway.

Norway's Ministry of Climate and the Environment, Ministry of Trade, MFA and NORAD, as well as NICFI and the Environment Directorate are likely to be supportive of sustainable palm-oil biofuels from Los Llanos, for climate-related and developmental reasons. Other important actors might include civil society like churches, labor organizations like the Norwegian Confederation of Trade Unions (LO), employer and trade organizations under the Confederation of Norwegian Enterprise (NHO), and others.

The more actors that adhere to such informal coalition advocating for or at least tacitly accepting biodiesel from sustainable palm oil, the less likely is the risk of a bad public image. NGOs positive to the imports from Los Llanos are not likely to express support for explicit projects *ex-ante* as they do not want to be perceived as guarantors of compliance to requirements.

7.5 Stepwise development possible

The 60,000 ha project at El Cimarrón described in this project development plan will be implemented in a stepwise manner. The current pilot of 625 HA palm planation and a small extraction mill will demonstrate that the project is possible to realize. The next step will be to build the first of the five 300,000 mt/ year palm-oil extraction mills and planting 13,000 ha of African palm to supply enough fruits to exploit the full capacity of the extraction mill. Whether

the construction of a small-scale refinery and biodiesel plant is profitable and compatible with the projected growth of the project is still under study. However, refining and processing biodiesel could be outsourced within Colombia and then brought to the international market.

This implies that Prestige will able to supply any agreed quantity, small or large, with a specific partner, independent of other signing customers. Prestige is hence able to guarantee the delivery to forward contract of any size.

The time needed to develop 60,000 ha palm oil plantation will depend on the resources put into the planning and execution. The current organization would be able to plant 2,000 ha a year, but with more resources available would 5,000 ha a year be achievable (in line with indicated capacity of other Colombian producers). The full plantation will hence be ready in 12 years, or 2030 if the planting process starts in 2018. Another possibility that will speed up the process is to entail in a cooperative effort with other producers in Colombia through the palm growers federation Fedepalma. Their joint capacity will probably make it possible to realize a total of 60.000 HA plantation in one or two years, with first harvest 2023-24 if sufficient nursery capacity is established in 2018. This will require a separate certification processes on of the sites.

8 References

Dane. (2010). *Censo general 2005 – Proyecciones nacionales y departamentales de población 2005-2020 (General census 205 - Projections of national and department populations 2005-2020)*.

DNP. (2010). *Aspectos básicos grupos étnico indígenas (Basic aspects of enthnic indigenous groups)*.

Duarte. (2016, 11/15). Donde podian quedar los Zidres? (Where would ZIDRES be established?). *La Silla Vacilla*.

EIA. (2015). *Who watches the watchmen? Auditors and the breakdown of oversight in the RSPO*.

EC. (2016a). *Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the promotion of the use of energy from renewable sources (recast)*. Brussels, Belgium

EC. (2016b). *Annexes to the Proposal for a Directive of the European Parliament and the Council on the promotion of the use of energy from renewable sources (recast)*. Brussels, Belgium.

EU. (2009) *DIRECTIVE 2009/28/EC on the promotion of the use of energy from renewable sources,*

EU. (2012). Recognition of RSPO RED scheme. *Official Journal of the European Union*.

EU. (2015). *DIRECTIVE 2015/1513 amending RED*.

EU. (2017). EU accepted RED certification companies. Retrieved from https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

Fischer, C. (2004). The complex interactions of markets for endangered species products. *Journal of Environmental Economics and Management, 48*, 926–953.

Garcia-Godos, J., & Wiig, H. (2014). *The Colombian land restitution process - Process, results and challenges, with special emphazis on women*. Retrieved from: http://www.colombialandgender.org/images/pdf/GGW_2014_Land.pdf

García Reyes, P., & Wiig, H. (2017). On bread and justice - Land restitution and investments in Colombian agriculture. *World Development, forthcoming*.

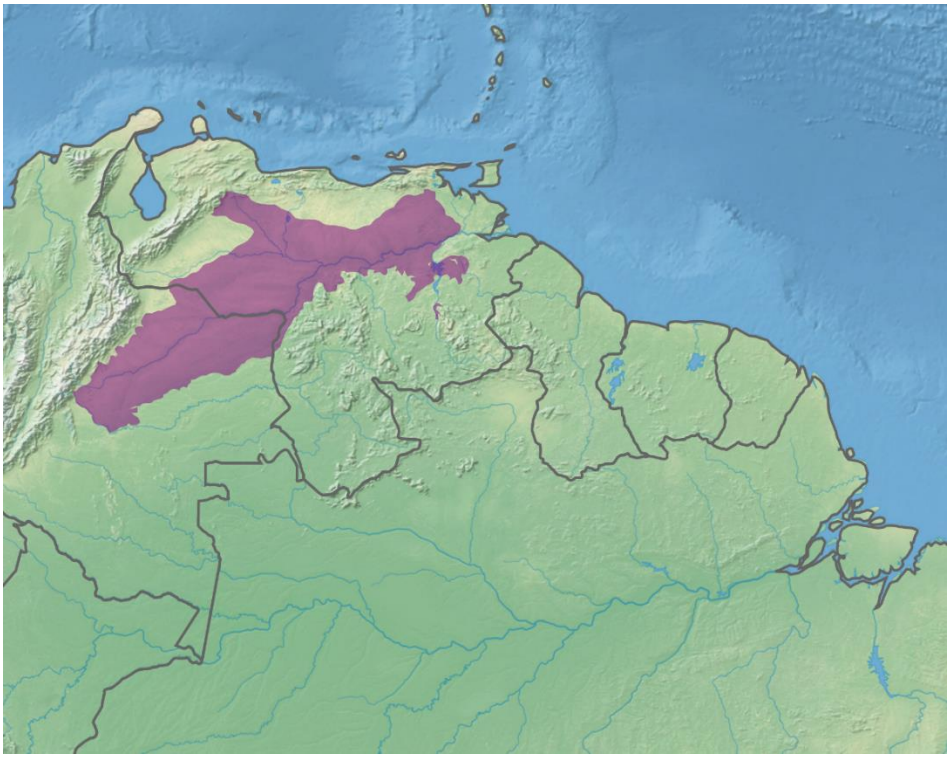
Gmünder, S. (2017). *Carbon footprint of sustainable biodiesel from palm oil on El Cimarrón,* Quantis International evaluation: Bogotá
GoC. (2010). *Plan nacional de desarrollo, tomo I (National development plan, part I)*.
GoC. (2014). *Politica para el desarrollo integral de la Orinoquia. Altillanura fase I*.
GoC. (2015a). *Plan Maestro Fluvial de Colombia 2015 (River master plan of Colombia 2015)*.
GoC. (2015b). *Plan nacional de desarrollo 2014-2018 (National development plan 2014-2018)*.
GoC. (2016a). *Acuerdo final para la terminacion del conflicto y la construccion de una paz estable y duradera (Final agreement for the termination of the conflict and constuction of a stable and durable peace)*.
GoC. (2016b). *Ley 1776 Zonas de Interes de desarrollo rural, economico y social, Zidres (Law 1776 rural, economic and social development interest zones)*
Holtsmark, B. (2015). A comparison of the global warming effects of wood fuels and fossil fuels taking albedo into account. *GCB Bioenergy, 7*, 984–997.
Howard, E. (2015, 9/2). Critics fear RSPO's stricter palm oil standards will create two-tier system. *The Guardian*.
IGAC. (2012). *Mapa de resguardos indígenas (Map of indigenous reserves)* Instituto Instituto Geografico Agustin Codazzi: Bogotá
Lange, M., & Suarez, C. F. (2013). *Eu biofuels policies in practice - A carbon map for the Llanos Orientales in Colombia*.
Melbye A., & M. Holm. (2016, 4/12). Biodrivstoff er ingen trussel! *Klassekampen*.
MoEF. (2014). *Statistics of the Ministry of Environment and Forestry 2014*.
NER. (2016). *Nordic Energy Technology Perspectives 2016 - Cities, flexibility and pathways to carbon-neutrality*.
NICFI. (2015). Joint declaration on Cooperation on reducing greenhouse gas emissions from deforestation and forest degradation (REDD+) and promoting sustainable development in Colombia.
Norge vel (2014) Consultant's report to the renewable energy manager under Rural Urban Development Initiative (RUDI), Norges vel report
Oxfam. (2013). *Divide and purchase - how land ownership is being concentrated in Colombia*.
POIG. (2013). Palm Oil Innovations Group Charter V1.
POIG. (2016). *Palm Oil Innovation Group Verification Indicators March 2016*.
PoN. (2016). *Instructions on state budget 2017 to governm*ent. Parliament of Norway
Robinson, J. A. (2016). *The misery in Colombia.*
Robles (2014) Demanda de inconstitucionalidad ZIDRES - expediente D-11494, (2016)
Quantis (2017) Carbon Footprint of Biodiesel from El Cimarrón, Colmbia, consultancy report by Quantis International for Prestige Colombia SAS, Bogota,
RSPO. (2012). *RSPO-RED requirements for complience with the EU Renewable Energy Directive requirements*.
RSPO. (2013). *Principles and criteria for the production of sustainable palm oil 2013*.
RSPO. (2016). *Colombian national interpretation of the RSPO 2013 principles and criteria for the production of sustainable palm oil*.
Snøhetta, P. a. (2002). *COLOMBIA 2020 A Profitable Social Investment Feasibility Study - Part I*.
Strang, J., Babor, T., Caulkins, J., Fischer, B., Foxcroft, D., & Humphreys, K. (2012). Drug policy and the public good: Evidence for effective interventions. *The Lancet, 379*.
El Tiempo (2008, 5/6). Más de 38 mil hectáreas del Vichada pasaron ilegalmente a manos de amigos de senador Habib Mehreg (More than 38000 hectares in Vichada pased illigally to the friends of senator Habib Mehreg). *El Tiempo*. Retrieved from http://www.eltiempo.com/archivo/documento/CMS-4237237
El Tiempo, (2016, 12/13). Corte aprueba el 'fast track' para implementar acuerdo de paz. *El Tiempo*.
UN. (2015). *World population prospects revision 2015 - Key findings and advanced tables*.
Universal, E. (2016, 30/10). "En Colombia hay dos millones y medio de predios en la informalidad" (there are two and half million informally registered plots in Colombia). *El Universal*.
USDA. (2016). *Oil seeds world market and trade,* United States Department of Agriculture.
Wikipedia. (2017). *Terra Preta*.

9 Appendix

9.1 Colombian regions

Map 1: Regions of Colombia

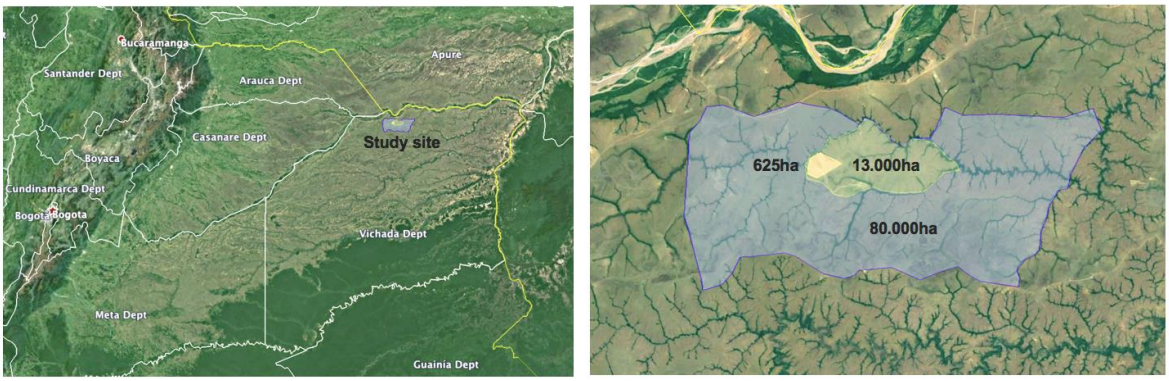
9.2 Los Llanos region



Map 2: The combined area of Los Llanos region in Colombia and Venezuela, colored area about 40 million HA.

Photo 1: A typical landscape in Vichada department of the Altillanura region. In the forefront we observe savannah used for extensive cattle herding degraded by fires, and in the background a palm oil plantation.

9.3 Designated area for El Cimarrón project



Map 3: The total project area of the El Cimarron project will cover 80.000 HA as 25% is set aside for environmental protective measure, net cultivated land is 60.000 HA. Prestige has property title to 13.000 HA (green area) on which 625 HA (yellow area) is today planted with mature palm from which the company produce palm oil.

9.4 Extraction process

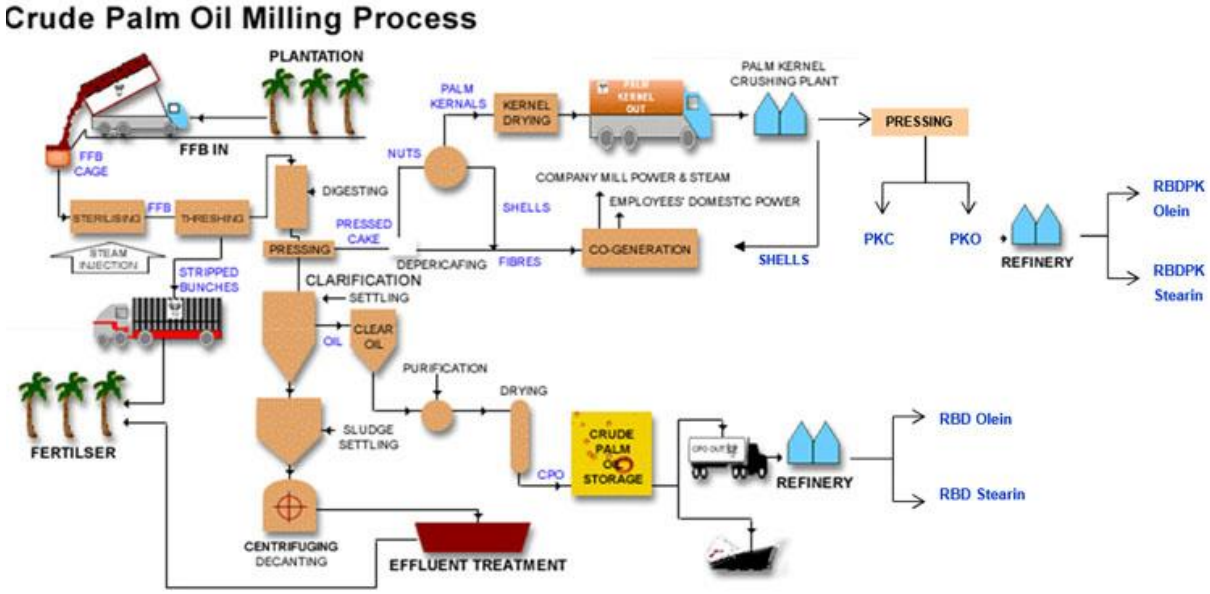
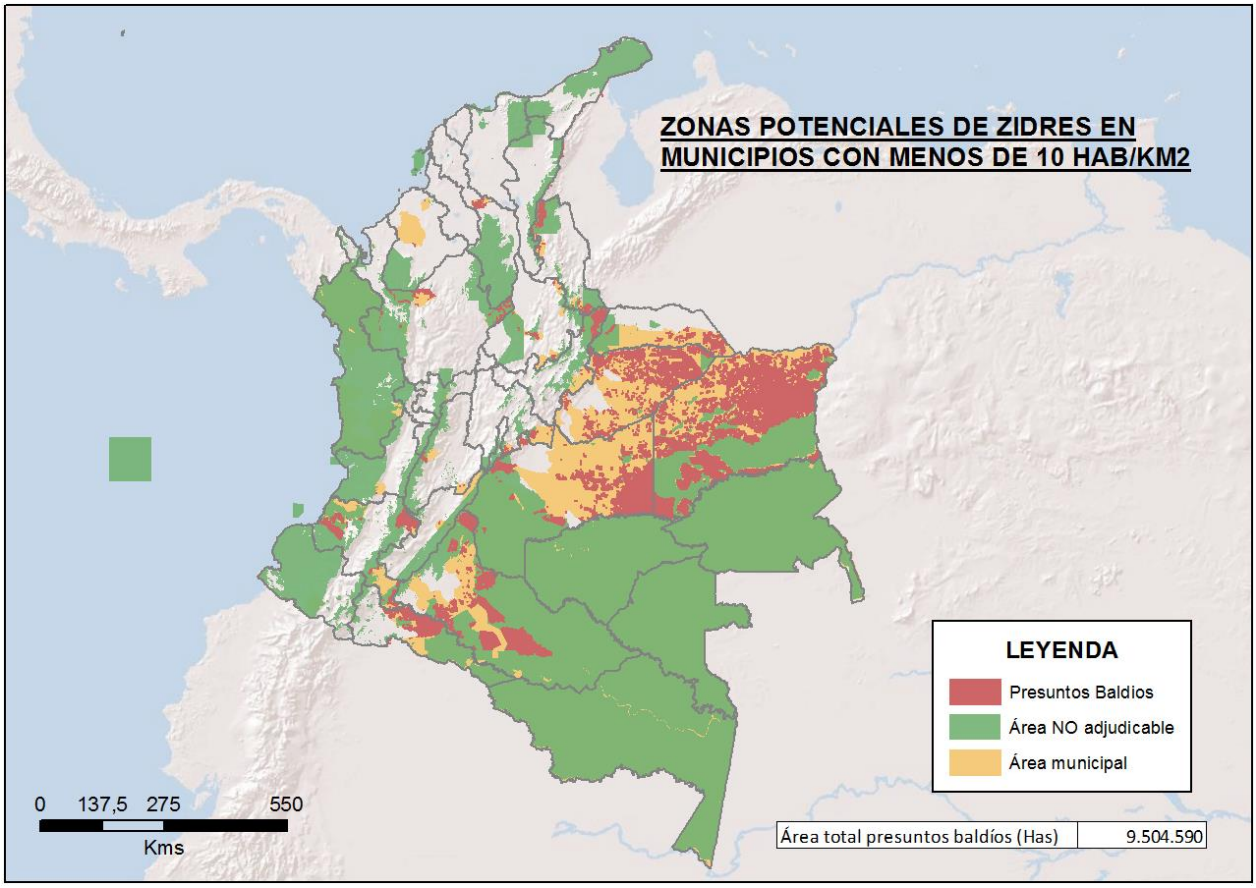


Figure 1: The extraction process of palm oil. The fruit bunches (FFB) are brought in from the field, then sterilized and threshed. The fruits are pressed, and the oils clarified into CPO and the remaining effluents. The kernel is separated from the remaining pressed cake processed to kernel oil. The kernel shells and parts of the residuals from all part of the process us input to heat water for the process and electricity production on El Cimarrón. The remaining residuals will be cut into small pieces and mixed with effluents under hot air to produce organic fertilizers

9.5 Coca producing areas in Colombia

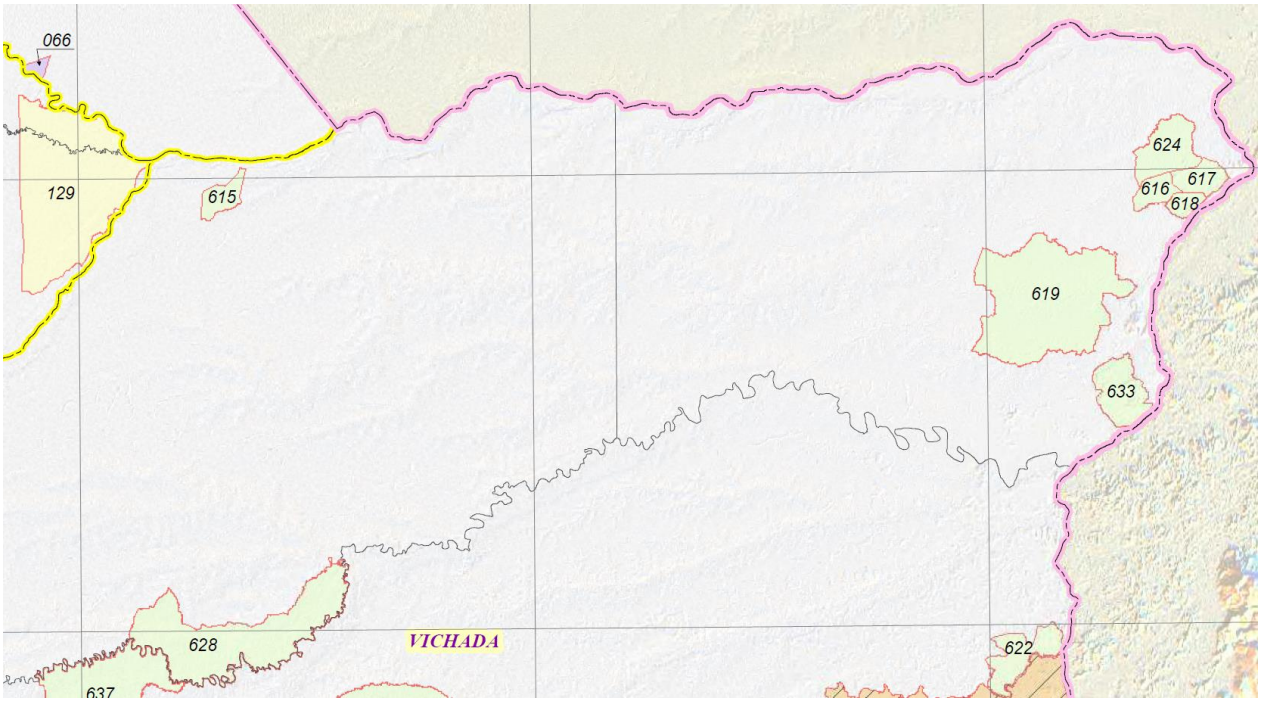
MAP 4: Coca producing areas in Colombia

9.6 Areas eligible for industrial agricultural



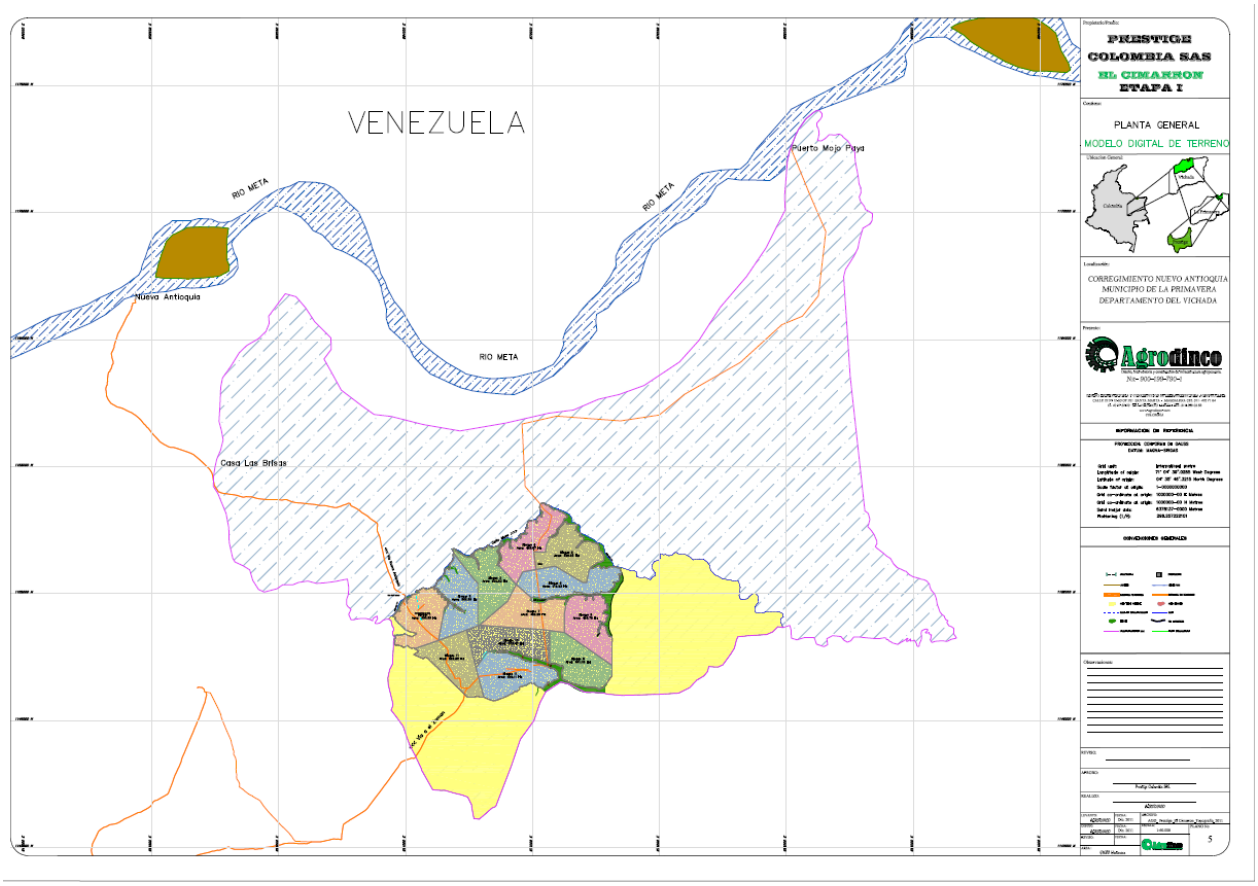
Map 5: Areas eligible for industrial agricultural zombification according to the conditions set in the ZIDRES law with according normative regulations. The relevant areas on presumed idle state land of 9.5 million HA is marked in read, while private on land on eligible low populated municipalities is marked in yellow (Duarte, 2016)

9.7 Indigenous reserves – Vichada



Map 6: Indigenous reserve 615 in upper right part of the map: Campo Alegre y Ripialito, la Primavera, Vichada, Colombia. There are no other indigenous reserves in this region of Vichada (IGAC, 2012) The third unrecognized indigenous group lives on or close to this reserve.

9.8 Prestige's certificate of possession



Map 8: The current property of El Cimarrón with registered title in colors. Land claimed by Prestige as they have "certificate of possession" in shaded area.

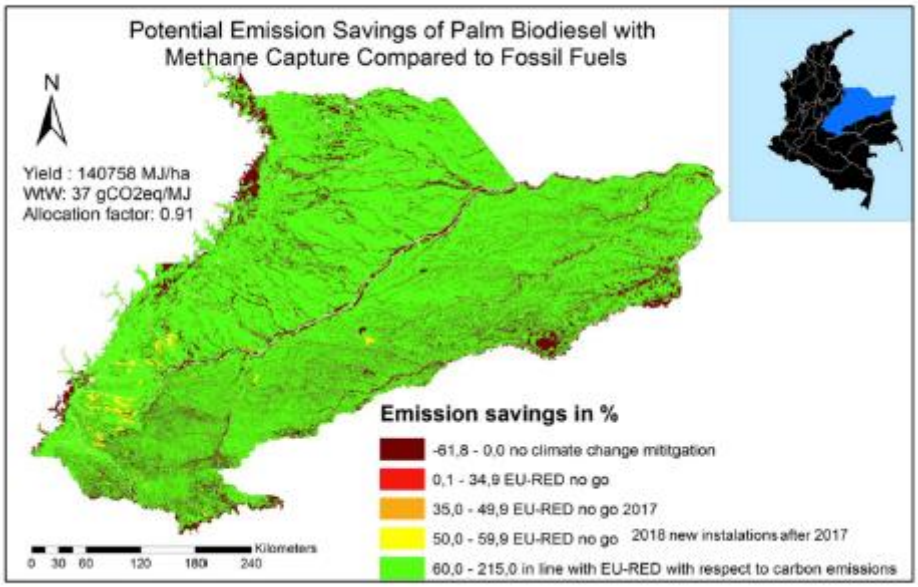
9.9 World vegetable oil production

	Mill MT	%
Coconut	3,41	1,8
Cottonseed	4,54	2,4
Olive	2,82	1,5
Palm	64,5	34,7
Palm kernel	7,64	4,1
Peanut	5,63	3,0
Rapeseed	26,79	14,4
Soybean	53,65	28,9
Sunflower	16,74	9,0
Total	185,72	100,0

Table 1: Annual production of major vegetable oils, World 2015/2016 (USDA, 2016)

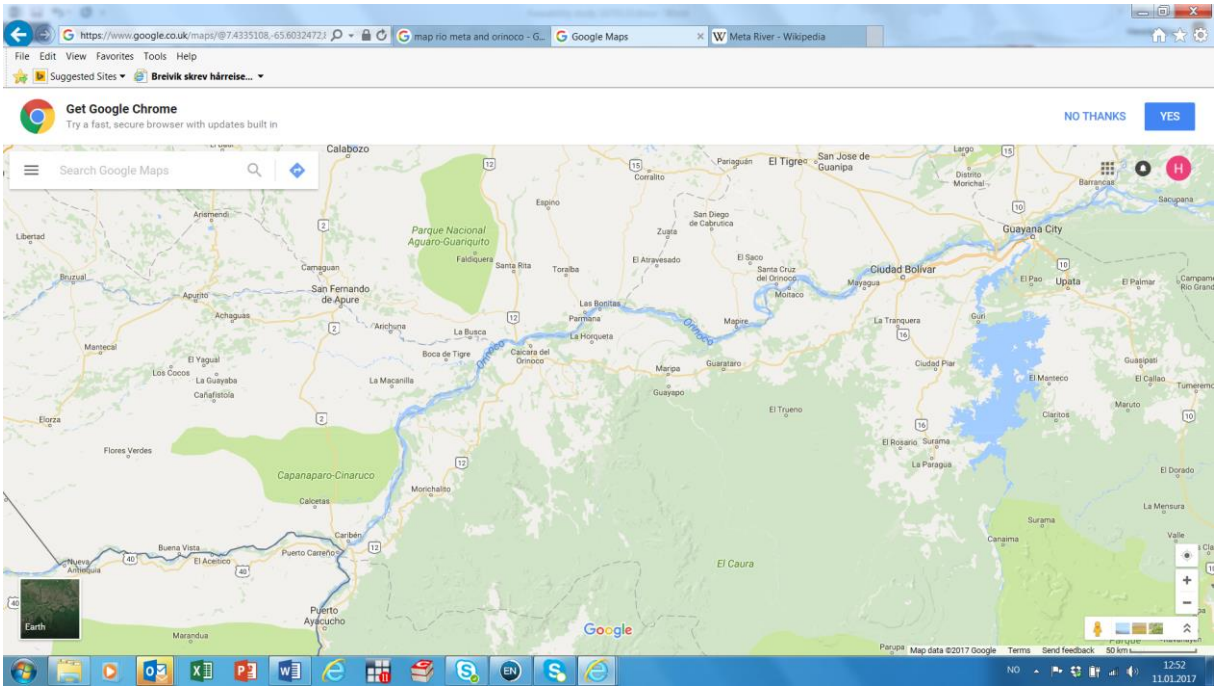
9.10 Emissions savings on palm biodiesel in Los Llano

Figure 7[13]



Map 7: Green areas demark land where the life cycle GHG emissions form biodiesel from oil palm are less than 40 percent of emissions from fossil fuels (Lange & Suarez, 2013)

9.11 River transport route



Map 8: Transport from Nueva Antioquia (bottom left corner) on Meta river, via Puerto Carreño where it joins the Orinoco river after 270 km, and to Puerto Ordáz in Guayana City for transfer to oceangoing vessels (upper right corner) after about 1500 km.

9.12 Land efficiency of vegetable oil

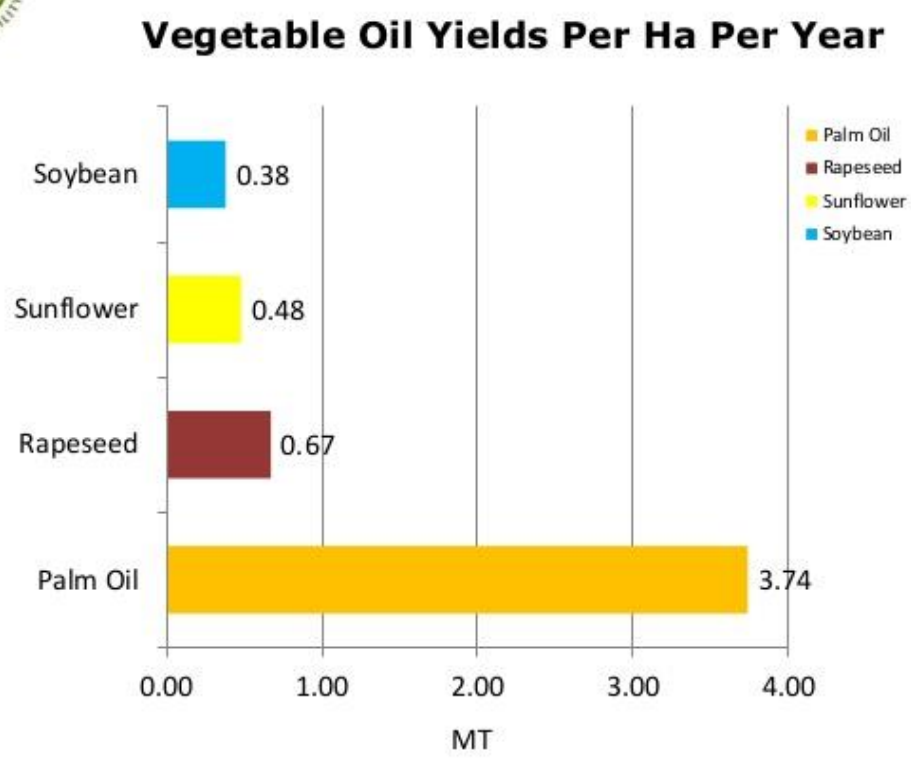
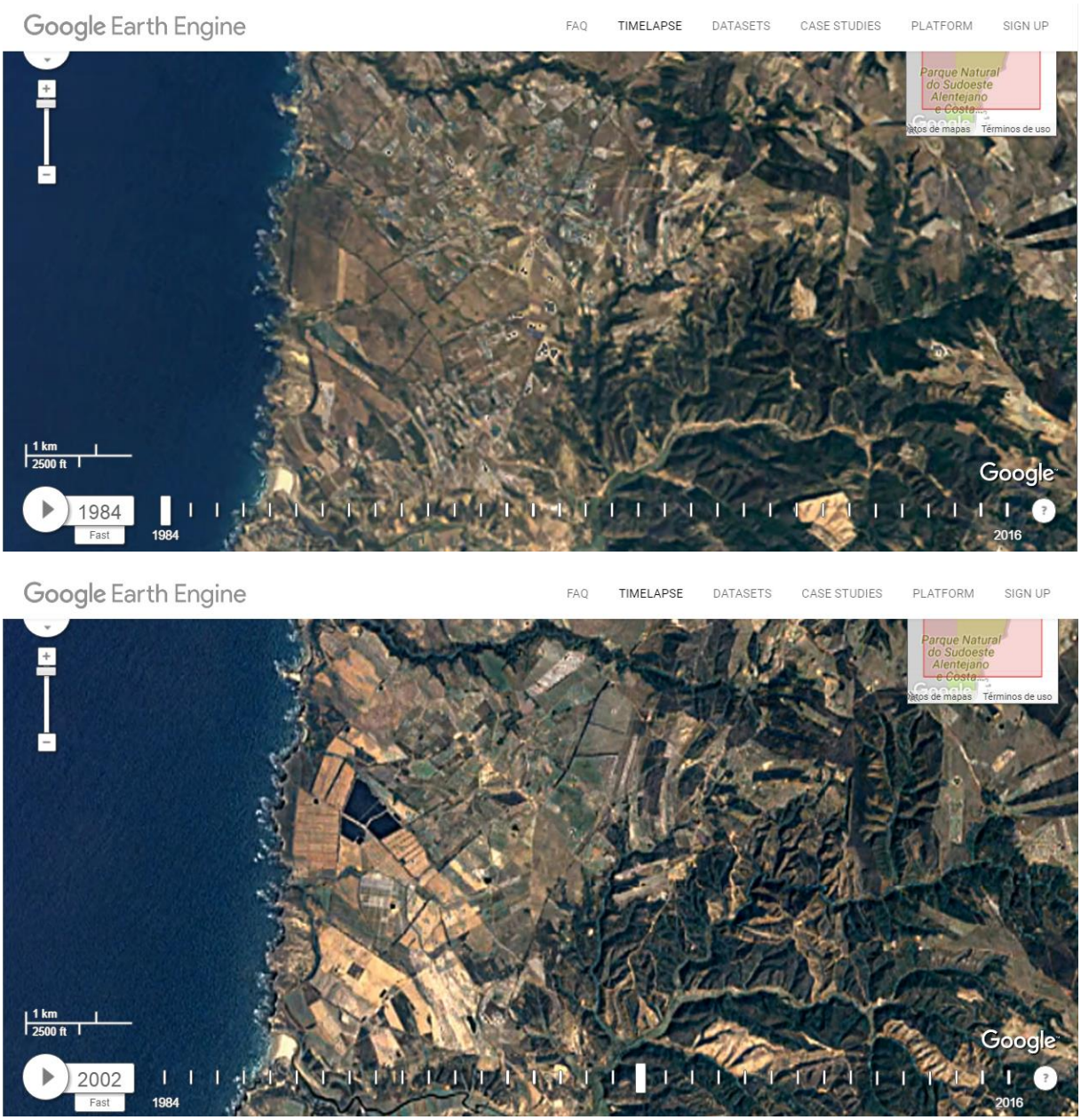


Figure 1: Production of vegetable oil per hectare, palm oil is extremely more land efficient

9.13 Frupor developed agricultural cluster in Portugal



Satellite photo 1 and 2: Development of the Brejão district, before and after Ole Martin Siem with his Frupor company as the first large scale agricultural actor in the area started to invest in export oriented agriculture in 1988.

9.14 GHG emission reduction in baseline scenario

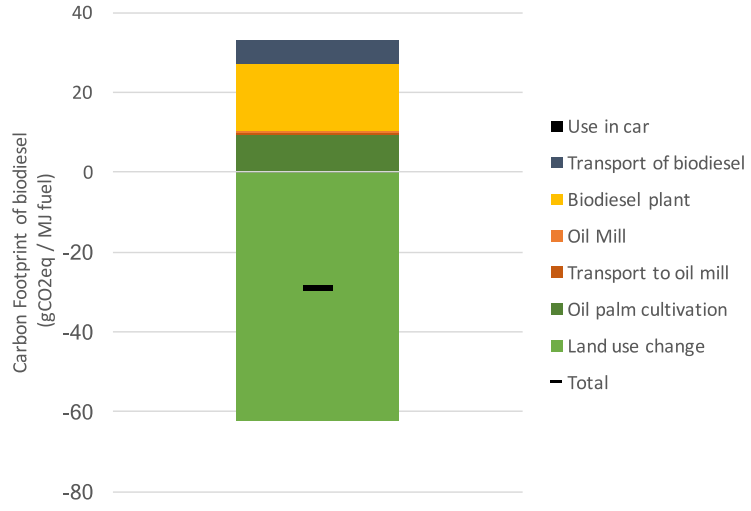


Figure 2: Baseline scenario CO2 equivalent emissions by source, notice land use change is negative as there is more carbon in palms than former savannah, Source: Gmünder (2017)

Figure 3: Reduction of GHG emissions at El Cimarron in different scenarios, baseline is 134% compared to fossil diesel, if replace grassland or scrubland or gallery forest with more carbon storage to demonstrate the effects of departing from the chosen strategy only using the degraded lands, when land use effects does not count after 20 years according to current EU RED rules, finally if chose not to auto generate electricity and export through Colombia rather than Venezuela, Source: Gmünder (2017)