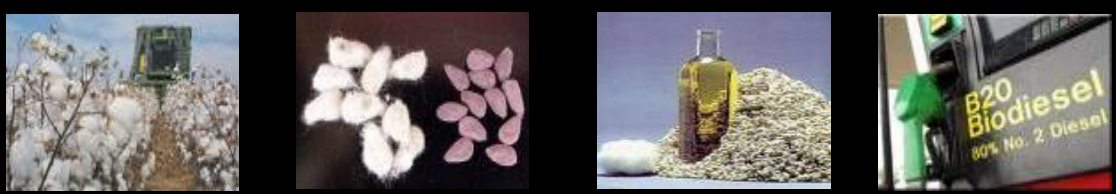
CODEVASF

INTEGRATED PROJECT OF SUSTAINABLE BUSINESS

BIO-ENERGY PRODUCTIVE CHAIN

INVESTMENT OPPORTUNITIES IN COTTON PRODUCTION IN THE SÃO FRANCISCO AND PARNAÍBA VALLEYS



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INTEGRATED PROJECT OF SUSTAINABLE BUSINESS – PINS

BIO-ENERGIA PRODUCTIVE CHAIN:

INVESTMENT OPPORTUNITIES IN COTTON PRODUCTION IN THE SÃO FRANCISCO AND PARNAÍBA VALLEYS

CODEVASF, Brasília, DF

2009

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Executive Summary

Various facts have drawn global attention towards the adoption of biofuels. Oil prices, global warming and growing international demand of energy, as the main ones. Thus, many countries have invested in bio-energy production systems, while setting national programs of partial addition of between 5% to 20% biofuels on the commercialized fossil fuels. Among those biofuels is the biodiesel, obtained from vegetable oils, which is intended to take a share of the energy consumed by diesel engines.

Soy bean was the main supplier of vegetable oil for Brazilian plants during the first period of the Biodiesel National Program due its large culture scale already established. There is no lack, though, of interest on other cultures and oil sources that would be more profitable and a more competitive input.

Taking from this context, this study focus on the cotton culture due the compared advantages of the oil produced from its pit, the soil and climate conditions and the infra-structure available at Parnaiba and São Francisco valleys for the competitive production of high quality fibers and pits with high level of oil. The final goal of this essay is to present a economical viability analysis, with detailed and reliable information for potential investors that wish to produce irrigated cotton in São Francisco and Parnaiba Valleys, adding the safety of established business (fiber and vegetable oil) to the opportunity of a new added value of the biodiesel market.

This study is structured into topics where: from 1 to 3 there is a brief description of CODEVASF, of PENSA and success cases on the region. Topics 4 and 5 cover the concept of biodiesel and its characteristics, as well as the characterization of this new productive chain. Whereas topics 6 and 7 outlines the cotton productive chain and its specialties for the vegetable oil production for biodiesel, and a brief market analysis. On topic 8, the attractiveness of São Francisco and Parnaíba valleys for biodiesel production is stressed together with its advantages and potentialities for the agricultural production. Topic 9 brings the business model proposed for the São Francisco and Parnaíba valleys cotton chain insertion, using the PINS model (Integrated Project of Sustainable Business), as well as all the economical viability simulations projected. Finally, on topic 10, the necessary steps in order to make concrete the agro-industrial investment on the São Francisco and Parnaíba valleys are presented.

Summary

1. PENSA and CODEVASF

CODEVASF (São Francisco and Parnaíba Valleys Development Company) is a public office, related to the National Integration Ministry of the Brazilian Government, which aims the developing of the northeastern region through the irrigated agriculture. CODEVASF acts in the states of Alagoas, Bahia, Minas Gerais, Pernambuco and Sergipe, in an area of 640.000 km² of the valley, on the upper, lower and middle São Francisco River. According to the Federal law, 9.954, from January 6th, 2000, CODEVASF started acting also on the Parnaíba Valley, in an area of 340.000 km², covering the states of Maranhão e Piauí.

PENSA (Agribusiness Knowledge Center from the University of São Paulo) is an organization that gathers professors and researchers from Economy and Business departments of the Faculty of Economy and Business of the University of São Paulo (São Paulo and Ribeirão Preto). Its goal is to promote studies related to the Brazilin agribusiness.

PENSA has been invited to study the viability for the implementation of complete agro industrial systems in the area covered by CODEVASF. The study has been made for pineapple, apiculture, poultry, banana, bio-energy, caprine and ovine farming, dried fruits, orange, lime, fish and semi-processed vegetables.

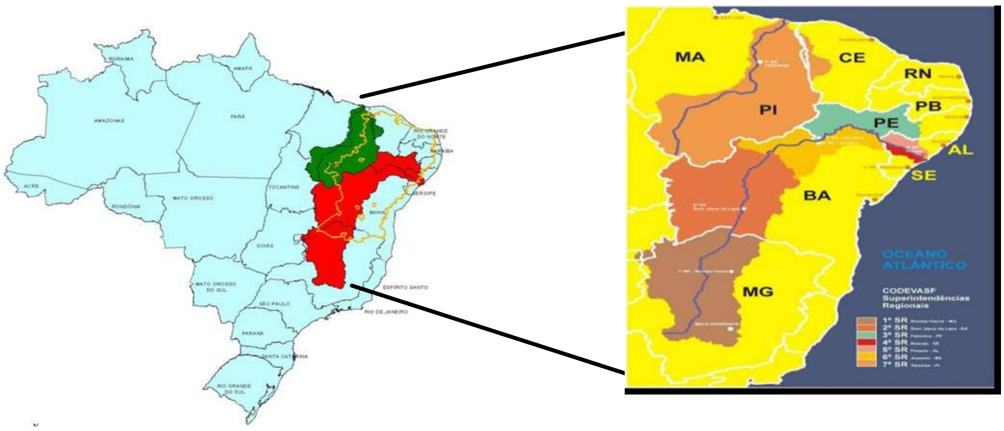
The project goal is to attract food and fiber companies well inserted on the national and international markets, and have the producers in the irrigated public areas as their suppliers. In order to do so, It was established the Integrated Project of Sustainable Business, where the “P”, of project, stands for the technical and economical and financial viability analysis developed for the applying companies, the “I”, of Integrated, stands for private mechanisms of contracts and relationships between agro industries and small producers suggested, the “B”, of business, stands for the desirable profit rates for the anchor agro-industries calculated, as well as the desirable income for the small producer and, finally, the “S”, of sustainable, stands for social, environmental and economical aspects that should be evident.

The goals, as pointed by the company, are the “creation of labor and income, reduction of migratory flux due economical and social effects of the frequent draught and flood, and also the preservation of natural resources of São Francisco and Parnaíba rivers for the better quality of life of the people living in those areas”. For that purpose, CODEVASF is organized regionally and divided into 7 administration offices, called regional offices, acting on the middle, sub-middle and lower São Francisco River. In the middle São Francisco are located the Montes Claros (Minas Gerais) regional office (1st regional office) and Bom Jesus da Lapa (Bahia) regional office (2nd regional office). In Montes Claros there has been developed local productive arrangements for apiculture, ovine and fish farming, being the productive stand out the Jaiba Project, with irrigated fruit culture, mainly banana, lime and mango. In Bom Jesus da Lapa, the mainly projects are at Baixio do Irecê, Barreiras do Norte, Barreiras do Sul, Estreito and Formoso. In those areas, the most prominent is the irrigated fruit culture, specially banana and mango, as well as the grain production in Barreiras do Norte. Besides, the region is also strongly developing its bioenergy potentiality through the ethanol and biodiesel.

In the sub-middle region of the São Francisco River Valley are located Petrolina (Pernambuco) regional office (3rd regional office) and Juazeiro (Bahia) regional office (6th regional office). The irrigated fruit culture is well developed in this area, mainly mango, grape and coconut. Whereas in the lower São Francisco is Aracaju (Sergipe) regional office (4th regional office), and Penedo (Alagoas) regional office (5th regional office). Due the plain topographic conditions, low altitude and abundant water resources, the region has strongly developed the rice culture and it is currently developing fish farming on caved tanks, producing Tambaquis (*Colossoma macropomum*) and Tilapias (*Oreochromis niloticus*) for the local markets. Finally, in the Parnaíba River valley CODEVASF is represented by Teresina (Piauí) regional office (7th regional office). In this region, the focus is the management of the semi-arid areas in order to revigorate fauna and flora and to develop apiculture and caprine farming as sustainable economic activities.

2. Characteristics and Competitiveness of the São Francisco and Parnaíba valleys

São Francisco Valley occupies an area of 640,000 Km^2, of which 36.8% is in Minas Gerais, 0.7% in Goiás and Federal District, and remaining 62.5% is located in the states of Bahia, Pernambuco, Sergipe and Alagoas. Parnaíba Valley is in the Northeastern area of Brazil, covering a total area of 330,000 Km^2, of which 75.73% is in Piauí, 19.02% in Maranhão, 4.35% in Ceará and the remainder in a litigious area.



Picture 1: Location of São Francisco and Parnaíba Valleys.
Source: CODEVASF (2007).

The population[1] of Petrolina and Juazeiro[2] region is about 570,000 inhabitants, of which 68% living in urban areas and 32% in rural areas. 86% of the houses have electricity[3], 57% have plumbing and 85% disposal services.

[1] Demographic census, 2000.
[2] Due the great extension covered by São Francisco and Parnaíba valleys, the region of Petrolina and Juazeiro was used as a reference for the presentation of the characteristics of competiveness.
[3] IPEA, 2000

Table 1: Summary of socio-economical data.

City	State	Population	GDP per Capita (R$)
Petrolina	PE	218.538	5.668
Lagoa Grande	PE	19.137	5.936
Santamaria da Boa Vista	PE	36.914	5.043
Orocó	PE	10.825	6.279
Juazeiro	BA	174.567	4.347
Sobradinho	BA	21.325	13.337
Casa Nova	BA	55.730	2.382
Curaçá	BA	28.841	3.196

Source: IBGE (2008).

Regarding education, literacy rate is 74%, life expectancy of 65 years old and infant mortality of 4.9%. In the area, there are about 37 thousand secondary school students and 7,000 at higher education. The GDP of the Petrolina and Juazeiro area is around R$ 3 billion, bringing the annual GDP per capita average to R$ 6,500.

Petrolina and Juazeiro area is located at 8 ºS latitude, at an average height of 365 meters. Climate is semi-arid, warm and dry, with monthly rain of 44mm concentrated on the first semester; insolation is 3,000 hours per year, with 300 days of sun. This way, the average month temperature is 26^{O}C, 67% air humidity and monthly average evaporation of 7.5mm.

The soils in the area are plain with slight inclinations, with a minimum of 90 cm depth. At Pontal project, soils can be Podzolics or Latosoils. At Salitre Project, soils have poorly developed profiles and Cambisoils and Vertisoils are predominant

At some spots in the Petrolina and Juazeiro area, an underground drain system willl have to be implanted in order to avoid soil drenching in periods of heavy rain, reducing the risk of salinization of irrigated soils in semi-humid and semi-arid areas.

Fruit culture at São Francisco Valley has highly increased in the past years. The planted area covers around 100 thousand hectares, including private areas and CODEVASF areas and has grown an average of 9 thousand hectares per year, in the last three years.

Table 2: Fruit production profile at Petrolina and Juazeiro area.

PERMANENT CULTURE		
PERMANENT CULTURE	PRODUCTION (ton)	AREA (hectares)
Mango	224.000	13.256
Banana	186.060	9.083
Grape	51.560	4.363
Coconut	129.597	3.964
Guava	77.660	3.788
Papaya	10.459	521

Lime	793	101
Passion Fruit	3.859	627
Avocado	96	8
Orange	60	10

Source: Valexport (2007) and IBGE (2008).

As a reference, land cost in the Petrolina and Juazeiro area varies according to the geographic location, soil quality (natural fertility) and lot conditions. Empty land lots, that is, with no investments on irrigation equipments or undergoing culture, vary between R$ 1,000 and R$ 10,000/hectare.

Table 3: Data for the investment analysis at Petrolina and Juazeiro area.

Item	Work force/day (field)	Empty land	Water*
Cost	R$ 20	Between R$ 1,000 and R$ 10,000/ha.	R$ 71.42/hectare/year plus R$ 0.055/m3

Source: PENSA.
*Estimate. Water price differs from project to project.

Among the logistic options, the main ones are roads, seaports and airports. There are also railroad and river port options. For the road transportation, there is a number of roads. River ports make the grain transportation possible from west Bahia to Petrolina and Juazeiro ports. The water way is 1,300km long, from Pirapora in Minas Gerais, to Santa Maria da Boa Vista, in Pernambuco. As a reference, São Francisco River can be travelled for 100km more from Petrolina and Juazeiro.

Table 4: Cost of road transportation and distance from Petrolina and Juazeiro area.

Port		Salvador	Fortaleza	Recife	Rio de Janeiro	São Paulo
Distance (km)		511	878	721	1.928	2.241
Freight R$/t	Conventional	47	64	65	160	186
	Refrigerated	56	77	78	192	223

Source: PENSA.

Regarding the sea transportation, the largest ports in the Northeast region are located in Salvador, Fortaleza, Recife, São Luis and Natal. Distances are pointed in the following chart:

Table 5: Distance from Petrolina and Juazeiro to the main northeastern ports.

Port	Salvador	Pecém (Fortaleza)	Recife	São Luis	Natal
Distance	570 km	900 km	715 km	1200 km	850 km

Source: PENSA.

Another option is the Center Atlantic Railway, that links Petrolina to Salvador port (570 Km). There is also a project (Public/Private Partnership – PPP) to link Trans-northeastern road to Juazeiro, which will make the access to Maceió, Recife, João Pessoa, Natal, Fortaleza and São Luís ports possible and also making Salvador port less busy (it is estimated that the project will be concluded one year after its approval)

Petrolina International Airport is able to land most carrier planes, and due its geographic location, allow direct flights to U.S. and Europe, making the freight cheaper. It has an infrastructure ready to store 100 thousand fruit boxes on a climate controlled area and other structures that allow the export of perishable goods

3. Company Cases in the Region

The objective of this topic is to present some companies on the region, in order to show success cases at São Francisco and Parnaíba valleys. Key company cases in the region can help the competitiveness analysis, showing the necessary business orientation for small, medium and big producers.

Located near by Petrolina and Juazeiro, **Suemi Special Fruit** Company is an example for fruit production and exportation. It has started producing on 12 hectares and today it produces fruits on a 500 hectare area, exporting to many countries and using European retailer and USDA certificates. The company relies on a great packing house, employing over 1,000 workers, and using its own brand in the international market. Its high points have been quality control and international commercial management

Amacoco Company has set in Petrolina region aiming to take advantage of local coconut production for coconut water. Nowadays, it buys coconuts from various independent producers in an area of 800 hectares and has also invested in its own production areas. The greatest challenge of this company has been the establishment of a stable supply flow, since it has done an excellent work on the production transportation and on product management. Coconut water has reached a good acceptance on the isotonic drink market, and has also succeeded in food service chains. The capacity of the unit in Petrolina is 70 thousand liters per day.

Agrovale is a sugar cane processing plant for sugar and alcohol production and energy co-generation. Its production is set on a 20 thousand hectare area, and on 1.5 million ton of sugar cane being processed every harvest. Plantation is totally irrigated, reaching a productivity of over 110 tons per hectare. The semi-arid area production contradicts a paradigm by the difference of its management on an irrigated production. The plant is built on a CODEVASF project called Tourão, in the city of Juazeiro, in Bahia. All of its production is destined for supplying the very state of Bahia.

An important organization in terms of the sector coordination is **Valexport** – Orchard, Fruit, Poultry and By-products Producers and Exporters of São Francisco Valley Association. Today, around 50 producers and exporters are Valexport associates, which represents region's 70% production and 80% exportation. The scope of actions of this organization includes common interest actions of national and international communication, processing quality and efficiency of the existent productive chains. This factor is very important because it increases the possibility of coordinated actions and market intelligence.

One of the most fundamental organizations for the development of the Brazilian semi-arid area is **Embrapa Semi-Árido.** Created in 1975, Embrapa Semi-Arido seeks viable technological, competitive and sustainable solutions for the agribusiness in the region, for the benefit of society. One of its essential projects is the necessary diversification of cultures in the region. Cultures such as olives, peaches, citrus, cocoa, pear, among others, are tested and adapted. Embrapa is, today, a reference for the region as research center and support for producers.

Another case of a company installed in the São Francisco Valley that stands out by its market success and projection for the region is **Vinibrasil**. Creator of the idea of the project “New Latitude, New Attitude” the company has, together with other vineries in the region, built the São Francisco Valley brand. Originally from Portugal, the company has tested and developed varieties in the region, at its own farm in an area of 200 hectares with room to grow. Some of the wines that Brazil and the world have known and appreciated are Rio Sol and Adega do Brasil.

A cooperative that brings a key example of the insertion of small producers into the agribusiness is **Pindorama**, located in the lower São Francisco River, in the city of Coruripe (Alagoas). The model idealized by Berthlet, a French-Swiss who came in 1956 with the mission to settle families in lots, as colonies, producing on a cooperative system exclusively for sugar, alcohol, coconut by-products, passion fruit and acerola, besides dairy cattle. This model is unique by allowing the sustainable inclusion of small producers, and noticeable by making it with the sugar cane culture.

Another example of insertion of small producers into the agribusiness is the case of the partnership between **Itacitrus**, a private company for the production and distribution of lime on both internl and external markets, with **CentraJai** – Central of Project Jaíba Producers Associations. CentralJai has set a partnership with Itacitrus in August, 2007, aiming to expand its associates market by selling the lime on the external market and increasing their participation on the internal market. From November,2007 almost all of CentralJai lime production for internal market and all of it for the external market was commercialized by Itacitrus, which became responsible, inside CentralJai, for the trading management (internal and external sales) and for the quality management (standard checking of limes for both internal and external markets).

4. Agro-industrial system (SAG) and attractiveness analysis of the São Francisco and Parnaíba valleys for the irrigated cotton culture.

a. Cotton Agro-industrial System.

4.1.1. Cotton Culture

Cotton (Gossypium hirsutum L.) is a demanding plant regarding soil quality. Highly acid lands or lacking of nutrients, excessively humid or likely to get drenched, and also shallow or compacted soils are not favorable for the cotton culture. Regarding weather conditions, most of cultures, demand a water supply of 750mm to 900mm, fairly distributed during the cycle of 160 days, depending on the culture developing and production. For short cycle cultures (100-120 days) and medium ones (130-150 days) developed by Embrapa Algodão (Cotton), having in mind the northeastern semi-arid production, water supply demand drops to 450mmm to 700mm. The period for more water demand goes from blooming to fruiting, when hydric stress can reduce productivity up to 50% (Embrapa Algodão, 2003).

During the whole cycle, cotton culture needs predominantly sunny days, with average temperatures from 22 to 26ºC. When those conditions are met, cultures have been made successfully in altitudes from 200m to 1,000m. On higher altitudes, the cycle can be extended in 30 days or more. Cotton culture has a high nutritional demand, which can be supplied on the moment of the sow with the help of fertilizers.

Even though there are draught resistant varieties, more than 60% of world’s cotton culture is done with irrigation systems. That can be explained by the high gains of productivity these systems allow, especially the irrigation of mechanized cotton culture that, according to Embrapa Algodão (2003), can reach three times the productivity of the non-irrigated areas.

In Brazil, irrigated cotton culture has grown from the late 90´s, and the most common methods are the surface irrigation and the sprinkling, though the localized irrigation (Drip system) has gained more space.

There are two kinds of cotton plant: herb and tree that can be distinguished by their soil and climate demands, productivity rate (tons/hectare) and fiber quality. In the Brazilian Cerrado, for instance, the cotton herb culture is predominant. In the Northeastern semi-arid the cotton tree culture is predominant and the productivity is considerably lower. On the other hand, tree cultures are more resistant to draught, the fibers are longer and of better quality, with the possibility of natural colored fibers and organic production.

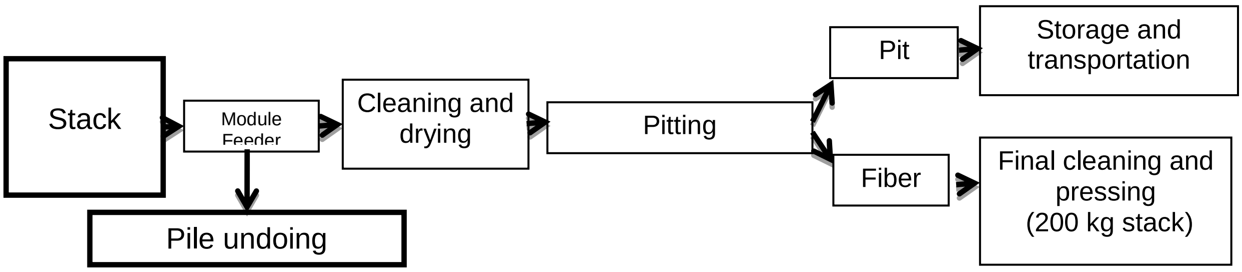
Besides increasing the productivity, cotton producers are also considering investments on cost reduction. One way out is the concentrated management. This technique, used successfully in Paraguay, Argentina and in the U.S., reduces the sowing lines from 90cm to 45cm and decreases the production cycle in 30 days, making also viable the fiber production in between harvest.

4.1.2. Processing

The main demand driver for cotton is the textile industry, which has its mechanism linked with the economical growth and income distribution. Cotton supplies approximately 60% of internal industry demand for fibers and filaments. When considering only natural fibers and filaments, its share grows to 97%. Polyester fiber and filaments are the next in terms of industry consumption, reaching 22% (ABRAFAS, 2008)

From 140 to 170 days after planting (depending on the culture), the harvest is done, mechanically nowadays. Cotton should be harvested dry and as clean as possible, not letting it for more than 10 days in open field in order to prevent damage on the fiber quality.

After harvest, cotton goes to the processing units where mechanical operations separate the fiber from the pit (seed). Besides fiber and seeds, there is a number of other materials called altogether "impurities" (sand, dirt, leaves, small fruits, other plant seeds, etc), also commonly called "break". It represents, in average, 5% of the gross product. Picture 2 presents the process for cotton processing.



Picture 2: Process for Cotton processing
Source: PENSA

The main product obtained after processing is the cotton. After separated from the pit, the cotton is classified. This classification is done in specific laboratories using high tech equipments.

The universal classification is composed of 5 numeric digits. First digit is type, second digit is color, third digit is leaf and fourth and fifth digit are universal code for length. For example, the universal classification (obtained on the classification certificate) 41237, means cotton type 4, color white, leaf 2 and length 37 (CONAB)

AGF operations (Federal Government Purchases) follow the instruction (MAPA No. 63, December, 5th, 2002) in which only white or slightly cream cotton are accepted (CONAB)

According to Freire (2005 apud MAPA, 2007), the Northeastern producers could benefit from their unique product, adding value up to: a) 20% over the reference cotton (type 6) if good types are produced, hand harvested with no external contamination; b) 30% if the fibers obtained are long or extra long (34-36mm and 36-

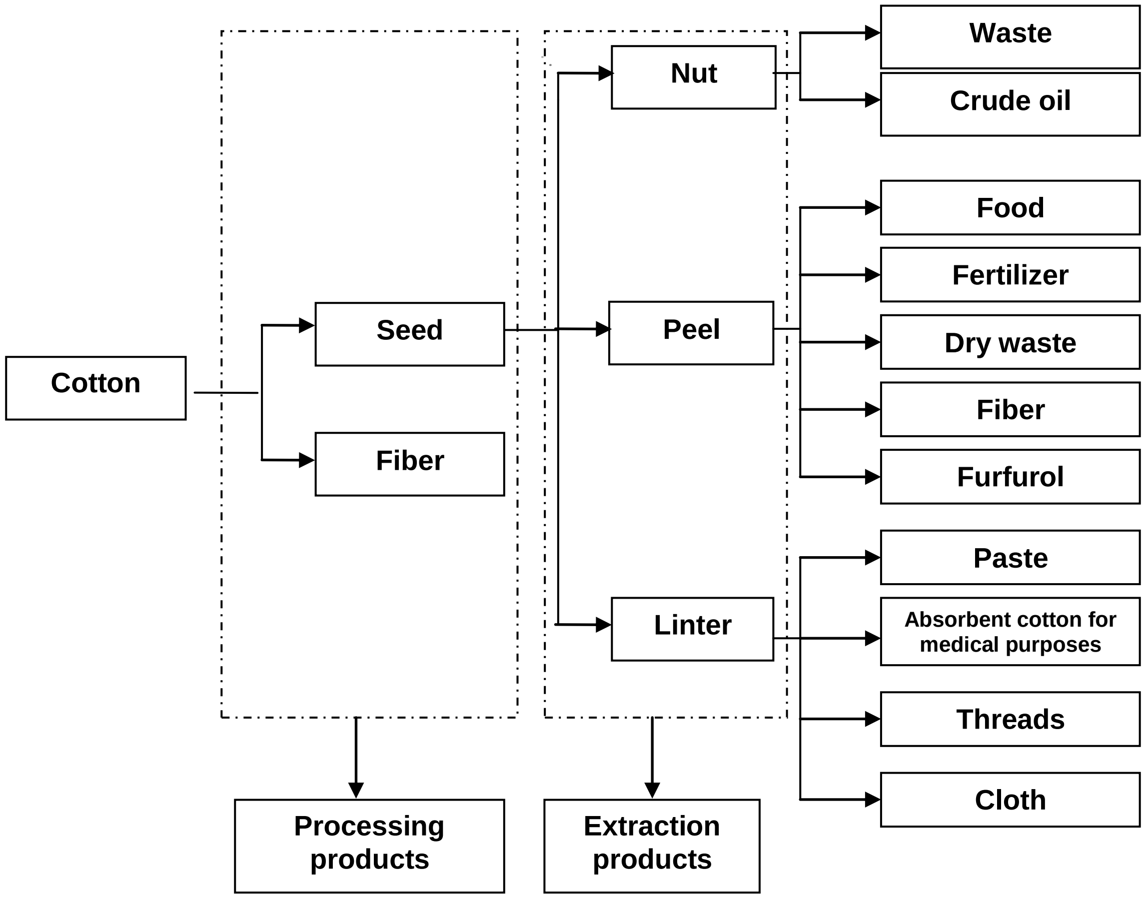
38mm), and fine (3.4 to 4.0mm) and resistant (over 32 to 34 gf.tex-1); and c) 100% for natural colored fibers (organic) and/or with social conformity certificate.

4.1.3. Cotton Oil Extraction

Another by-product coming from cotton culture that has obtained more and more economical relevance is the cotton pit. As a by-product, the pit has become a viable input for vegetable oil production, which, among other things, can be used on the biodiesel production, as well as the waste used in the animal food industry.

Cotton seed (pit), without the fiber, is composed, in average by: 12.5% linter, 15.2% gross oil, 46.7% waste (after oil extraction), 20.7% peel and 4.9% residual materials produced during the industrial processing (Embrapa Algodão)

During the oil extraction process, primary by-products are obtained, which are: linter, peel and nut; secondary: whole flour, gross oil, waste and dry waste; third: refined oil, waste and ungreased flour (Embrapa Algodão). Picture 3 summarizes cotton by-products.



Picture 3: By-products of cotton agro-industrial system
Source: PENSA

In the oil extraction industry, the peeler separates the peel from the nut. The nut contains the embryo (that originates a new plant) and up to 40% of the oil.

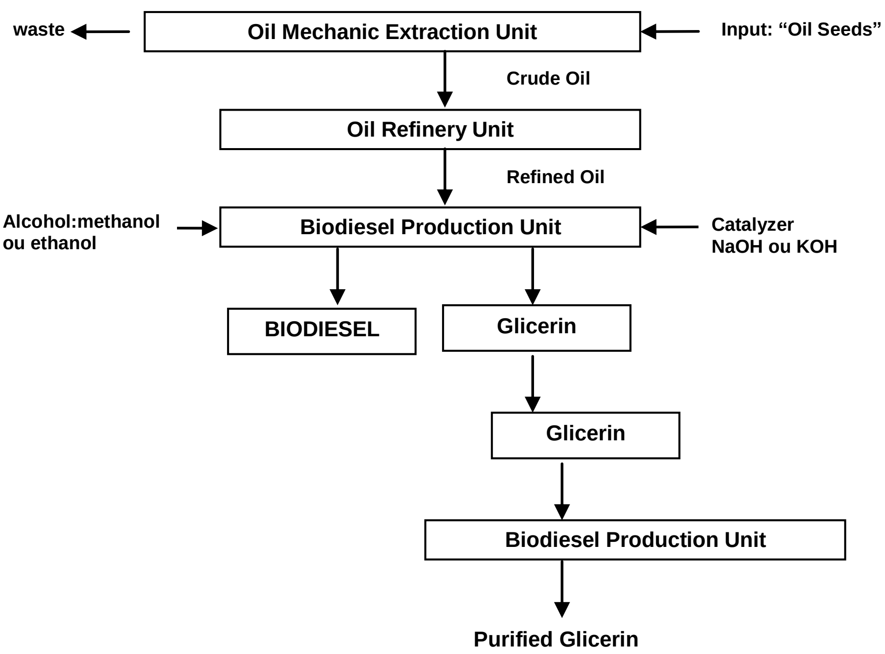
The peel has, in average, 8.7% water, 2.6% ashes, 3.5% protein, more than 45% carbohydrates and – only – around 1% fat. The peel has 3 to 8% linter and fibers below 3mm long. It is highly digestible and can be used pure or mixed with other products for animal food purposes, it does not need grinding and has 44 to 48% of gross fiber. It can also be used as fertilizer and fuel.

The oil extracted is dark colored, due pigmentation contained in the gossypol. The presence of this toxic component makes the refinery necessary in order to eliminate it through the heat, since it can be decomposed by heating it and can be destroyed during the refining.

Linter can be extracted through a process called de-lintering. It is classified according to the number of cuts processed during the de-lintering, which can be: first cut linter, second cut and third cut. First cut linter, which has longer fibers, is used on the production of hydrophilic cotton (absorbent) and surgical tissues. Second cut linter is used to produce cellulose, as well as third cut linter. In general, 50kg of liter can be obtained from a ton of seeds (Embrapa Algodão).

4.1.4. Biodiesel from the cotton pit

The process to produce biodiesel is simple and fully on public domain. Basically, it consists on putting together the vegetable oil or animal fat with alcohol to catalyze in order to occur the process of trans-esterification, in which the oil is separated from the glycerin. Picture 4 shows a sketch of the process of biodiesel production.



Picture 4: Process of Biodiesel Production
Source: Bahia State Government

Biodiesel has come as a new income source for the cotton culture. Nevertheless, compared to other cultures, cotton pit has a low oil performance (15.2%). Thus, cotton pit biodiesel performance is around 160 liters per ton of input (pit) (Parente, 2003)

On the other hand, studies carried by Embrapa Meio-Norte have proved that cotton pit is the input with the best potential for biodiesel production, as pointed by research coordinator José Lopes Ribeiro. According to experiments carried in Piauí and Maranhão, cotton pit, in general, has a oil rate that variesbetween 18 to 20% and an average productivity of 4.2 tons of cotton pit per hectare.

According to Catarina Riodrigues Pezzo, project coordinator of the Biofuel National Hub (PoloBio) from the University of São Paulo, the cheapest and most viable biodiesel is the one produced from the cotton pit. The fuel coming from the Northeast Region costs R$ 0.81per liter, followed by the fuel produced from soybean, in the Center-West Region, costing R$ 0.90 per liter.

PoloBio analysis was done in July, 2007 on a comparative basis in all five regions of the country an their main typical inputs: South Region, sunflower and soybean; Center-West Region, sugar-cane, cotton, soybean and sunflower; Southeast Region, peanut, soybean and sunflower; Northeast Region, castorbean, soybean and cotton pit; and North Region, palm and soybean.

A similar research, carried by the Logistics Study Center (CEL) from the Federal University of Rio de Janeiro (UFRJ), has concluded that the cotton pit biodiesel presents the lowest costs when compared to other oilseeds. The study has established scenarios with different levels of integration of productive chains, considering input, production, logistics and taxes costs, besides the income coming from the by-products (glycerin, waste and dry-waste) (Benzecry, 2008). As illustrated by table 6

Table 6: Chain costs (R$/L)

Integration level	Soybean	Cotton	Peanut	Sunflower	Castor seed	Palm
No verticalization	1,717	1,446	2,492	1,806	2,654	2,464
Agriculture/Processing Unit integration	1,717	1,442	2,490	1,799	2,645	2,464
Processing Unit/ Biodiesel plant integration	1,487	0,882	2,050	1,593	1,891	1,457
Agriculture/Processing Unit/ Biodiesel plant integration	1,348	0,881	1,890	1,725	1,828	1,302

Source: Benzecry, 2008

When there is no integration on the chain, the greatest advantage of the cotton pit biodiesel is the oil price, which was, in average, during the period considered by Benzercry (June, 2006 to April, 2007), R$ 968.00, while soybean oil was R$ 1,304.00. Whereas in the case of a totally integrated production, the income from the fiber sales gives the cotton culture a bigger advantage compared to other chains.

b. Attractiveness of the São Francisco and Parnaíba valleys for the Biodiesel Agro Industrial System

As infra-structure projects conducted by the Brazilian Government are carried on, São Francisco and Parnaíba valleys become a potential development hub for several agribusiness chains. The reasons that make those valleys especially attractive for the bio-energy chain are listed below.

CODEVASF work on São Francisco and Parnaíba valleys, while a sustainable development program, stimulates the biodiesel and/or vegetable oil production in the region, especially by investing on irrigation infra-structure, on research on region friendly cultures and on the strength of social organizations

Investments on São Francisco Valley area have good financing conditions, through the banks Banco do Nordeste Brasileiro (BNB), Banco do Brasil and BNDES for the region development as for the establishment of a bio-energy chain, making those investments even more attractive due a reasonable cost of capital and long term payments.

São Francisco and Parnaíba valleys have good structure for the regional products distribution in order to supply both internal and external markets. In terms of domestic market, the region is able to supply the whole Northeast Region that presents one of the biggest growth rates of the last years, and has a deficit in terms of biodiesel. Regarding the international market, the region is located on a privileged position, nearer from European and American markets

For the distribution of an eventual biodiesel production, São Francisco and Parnaíba valleys have a privileged hydro way structure, crossing the whole state of Bahia, from the north of Minas Gerais and connecting to railway net of Central Atlantic Railway (FCA), which links Petrolina and Juazeiro to the State capitals of Salvador and Belo Horizonte, besides contacting the Southeast Region. Besides that, São Francisco do Conde is a primary base for distribution that communicates with Juazeiro via railway, feeding two other distribution bases through ducts.

The most important fact is that São Francisco and Parnaíba valleys offer plenty of fertile land, including the availability of non-irrigated areas next to all irrigated areas, and good climate for oil seed production. For more water demanding cultures, there is a good irrigation infra-structure available, and good quality water and energy supply.

The quality climate and soil of the region, including the Federal stimulus for Biodiesel production and social integration (taxes, special credit lines, social certificates), sums up to a list of advantages that allow the start of a high scale biodiesel production in the region. This is an opportunity to create, inside the Brazilian territory, a new frontier for production without increasing the costs of food production in the country.

Chart 1 shows the advantages presented on the implementation of Biodiesel productive systems in the São Francisco and Parnaíba valleys.

Chart 1: Advantages presented on the implementation of Biodiesel productive systems in the São Francisco and Parnaíba valleys

Business Model	
Land distribution for producing companies	Less need for investments in the beginning of activities
	Less need for investments in equipments
	Less distribution restrictions
Production coordination done by investing company	Distribution guarantee and better processing planning
Integration of independent producers	No employer obligations and taxes on the relationship with the producers
Taxes	
Special taxation for biodiesel producers supplied by small family producers	31% tax reduction for semi-arid production of castor seed, palm and jatropha
	68% tax reduction for family producers
	100% tax reduction for family producers of castor seed, palm or jatropha
Funding Programs	
Preferable rates for biodiesel production	Funding at a cost of 6.25% (Long Term tax rate) + 1 to 3% (Social Fuel Certificate) for biodiesel producing companies
Preferable rates for investments that contribute for the development of the Northeast Region	Funding at a cost of 3.5% per year for the small producer in the semi-arid region
	Funding at a cost of 7.5% per year for the medium producer in the semi-arid region
	Funding at a cost of 8.63% per year for the big producer in the semi-arid region

Source: PENSA.

5. Funding at a cost of 3.5% per year for the small producer in the semi-arid region

a. Business Introduction

The business model aims the competitive production of cotton fiber as well as the viability of biodiesel production using cotton pit. In order to succeed, the relations between input producers, processing units, oil extracting units and, finally, biodiesel industries must be empowered

On the integration model promoted by CODEVASF, the investing company, called “anchor”, is granted by the Federal Government the right of use of the land (CDRU) for a period of 15 to 30 years, and must incorporate family producers into the business. Producers are selected by the anchor company and each one receives a lot that guarantees a minimum sustainable monthly income.

5.1.1. Agricultural production system

The decisions regarding the production system and managing structure for obtaining the irrigated cotton fiber and pit are due, exclusively, to the investor, as long as minimum 25% integration is met. In this section, an option that makes this condition viable is presented, and this model is used for the economical-financial viability simulation.

Brazilian cotton culture enterprise is remarkably intensive and technological. Practically all operations are mechanized and the productivity levels are reached through a great number of sanitarian applications. Besides demanding big investments in machinery and other implements and high input costs, this production system implies reduced profit margins and, thus demands scale gains.

Even when the family agriculturist is supported by cooperative, counts on a technical support from the anchor company and has credit access, the combination of high costs with low added value, makes the transportation of this system to smaller areas unviable

Therefore, it is appropriate to adopt a production system based on a less intensive use of technology, in order to reduce costs, but without compromising the supplies for the remaining rings of the productive chain. Thus, it is proposed a model that integrates two distinct production systems: an intensive one for entrepreneur cotton producers and a semi-intensive one for family cotton producers.

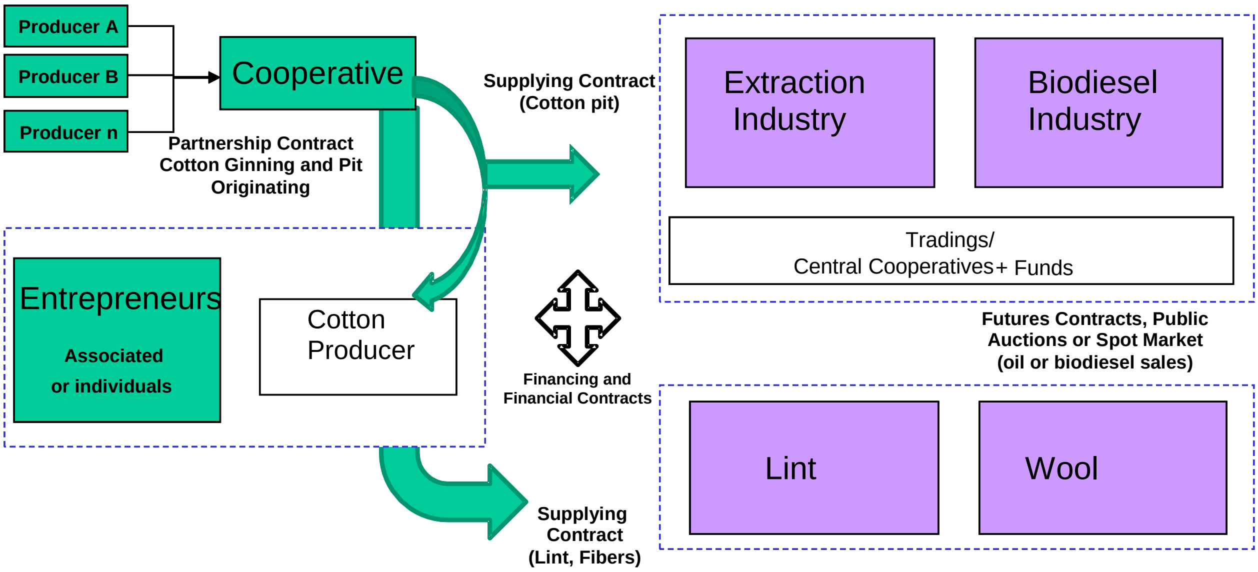
This study does not discriminate cotton varieties produced by big and small producers. However, it is important to note that the production of organic cotton and colored cotton in the integrated areas are distinction options that allow, on one side, the adding of value for the small productions and, on the other side, the opportunity for the anchor company to gain access to ever more important market niches.

b. Business Model

In the case of cotton business, the chain structure indicates the company anchor to be a big producer, because besides having the agricultural know how, it usually verticalizes the agricultural phase and the ginning process. The company can be, as well, formed by an association of producers. In this case, it would be formed a Society for Specific Purposes, here known as SPE (1), for the cotton business management.

To the company anchor is due to assist the integrated ones in terms of production, processing and commercializing. This model also proposes the formation of a family producers cooperative that is due to intermediate the relationship between these producers and the anchor company.

During the transformation phase, the cotton pit coming from the cotton production is purchased by a second SPE (2), which owns both the vegetable oil extraction unit and the biodiesel production unit. This SPE would have, as a major associate, a trading or an agro-industrial cooperative and, as a minor associate, an investment fund, which could have a special financing package for investments and productive capital. Picture 5 illustrates the business model?



Picture 5: Business Model – Panorama
Source: PENSA

5.2.1. Responsibilities

The best form of integration among anchor company and producers is the agricultural partnership. Under this type of contract, the producers from the cooperative should follow the anchor company agricultural planning. They receive technical assistance; use the processing service of the cotton gin unit; and can use bank financing directly or through the integrator company

As a counterpart, the SPE-1 (Society for Specific Purposes) processes all the seed cotton and commercializes all the agricultural products, creating scale opportunities for small producers when negotiating their products with the transformation industries. The incomes coming from lint, fiber and pit sales are distributed to the integrated producers after deducting the costs with technical assistance provided, a fee for the cotton ginning and eventual financing costs. The partnership with the anchor company can facilitate the production financing for the integrated producers, besides the guarantee, for those, of having a ginning service and assistance from the company

Under the supplying contract, SPE-1 commercializes the entire pit production with SPE-2 that sells the oil and/or biodiesel on the spot market or through futures contracts or public auctions. Here, in order to share risks and benefits, it would be interesting to link the pit price to the oil price.

Among the advantages of this model one can list: (i) benefits of a vertical integration without having to immobilize capital by purchasing land; (ii) coordination of agricultural activities, with mutual benefits among the agents involved; (iii) stimulus for entrepreneurship among family producers; (iv) biodiesel production in locations and inputs that do not compete with food production; and (v) Production sustainability, with the company setting its mark regarding social and environmental responsibility. This way, the functions of each agent is described on chart 2.

Chart 2: Functions of agents

Small Producers Cooperative	Agricultural Anchor	Extractor + Biodiesel Plant	Financial Agent
- Integrated under partnership contract with anchor. - Consolidates equipments and labors from integrated producers. - In time, it becomes responsible for input purchasing and distribution and technical assistance to the producer. - Manages sowing, maintenance and harvest activities. - Follows anchor[s agricultural planning. - Possibility of a minor share on the cotton gin unit and profits.	- Gets land right to use (CDRU). - Divides land into family lots and distributes them among selected families. - Defines the agricultural planning. - Makes its own production. - Guides the formation of the cooperative. - Provides technical assistance service to the producers. - Can assist on the input purchases and giving aval for financing. - Acquires and manages the irrigation system. - Processes and commercializes the integrated producer's cotton, distributing incomes after the costs deductions. - Supplies the pit for oil and biodiesel industries.	- Pit supplying contract with anchor, with price linked to oil price. - Oil and biodiesel production. -Commercialization through futures contracts, public auctions or Spot Markets (Oil and biodiesel sales)	- Funding for agricultural activity (production costs). - Funding for the implementing of vegetable oil processing and biodiesel industries. - Funding for irrigation systems. - Possibility of a minor share on the SPE's (Cotton gin unit, extractor, biodiesel plant) and profits.

Source: PENSA.

c. Economical viability analysis

This section presents the economical and financial results on a simulation of the implementation of the business model proposed by the Pontal Project, a CODEVASF irrigation perimeter, located in the city of Petrolina (Pernambuco), in an area of 8,000 hectares that can be irrigated. It is important to note that this is a simulation and that the results presented are not guaranteed by any of the parts involved on this elaboration.

5.3.1. Premises used

Before entering the details of the simulation, it is worth pointing out the premises adopted on this study in terms of project area, productivity and rentability, distinguishing entrepreneur systems from family ones.

Based on interviews with irrigated cotton producers in west Bahia region, Embrapa Algodão and irrigation material suppliers data, one can conclude that climate and soil characteristics of São Francisco Valley combined with the use of modern technologies of agriculture, make it perfectly viable the productivity to be around 10,000 lb/hectare of seed cotton for entrepreneur cotton producers and 5,000 lb/hectare for the family system.

For the necessary culture rotation, the option was the in between corn harvesting. Besides helping controlling pests, this option is an alternative source of income for the producer during the period between one cotton harvest to the next, using the same land.

It was also considered the necessary use of less demanding and less risky cultures on the first three years for what is usually called “opening of agricultural area”. For its demanding and highly risky nature, it is not viable to plant cotton on the first years of production on new agricultural areas. In areas of the Cerrado, like west Bahia, it is common to use soy bean on the first year, corn on the second and third, and cotton only on the fourth. Taking the obtained information regarding the soils on the Pontal Project, the opening of areas on the São Francisco valley for the cotton production would probably follow the same pattern as seen on the Cerrado.

Tables 7 and 8 bring the premises of productivity and production regarding the area, adopted on this study. The productivity levels presented refer to the use of drip irrigation. That is technology that allows the best productivity gains and the most rational use of water resources. Some countries already use this time of irrigation for the commercial production of cotton successfully. In Brazil, Netafim has obtained great results in experiments done with west Bahia and Mato Grosso producers. On family areas the dropping tubes stay on the surface and should be collected manually or with the use of proper equipment before each harvest. Whereas on the entrepreneur areas the dropping tubes should be dig, like it is done on sugar cane culture

Table 7: Cotton – Productivity and Agricultural Production

Anchor	**1 hectare**		**Total hectares**	**6,000**
	ton/ha	**Arroba*/ha**	**Tons**	**Arroba**
Cotton Lint	2.28	152	13,680	912,000
Pit	3.18	212	19,080	1,272,000
Seed Cotton	6.00	400	36,000	2,400,000
Cooperative	**1 hectare**		**Total hectares**	**2,000**
	ton/ha	**Arroba/ha**	**Tons**	**lb**
Cotton Lint	1.14	76	2,280	152,000
Pit	1.59	106	3,180	212,000
Seed Cotton	3.00	200	6,000	400,000

Total Production	Average Productivity		Total hectares	8,000
	ton/ha	**Arroba/ha**	**Tons**	**Arroba**
Cotton Lint	2.00	133	15,960	1,064,000
Pit	2.78	185.50	22,260	1,484,000
Seed Cotton	5.25	350	42,000	2,800,000

* Arroba=15Kg
Source: PENSA based on interviews with west Bahia producers; Netafim and Embrapa Algodão.

In the case of the in between corn harvesting, technological resources of both entrepreneur producer and family producer, once assisted by the cooperative and by the anchor, allow the same productivity results.

Table 8: Corn harvest – Productivity and Agricultural Production

Factor	Bag (60 kg)	Tons
Productivity (ha)	78	4.70
Total production	2,256	37,600

Source: PENSA

Regarding industrial results used on this simulation, it was obtained data from Cotton Products Unit of Aboissa Vegetable Oils, as well as from interviews with professionals acting on the various areas of cotton products processing and transformation. Those premises are presented on table 9.

Table 9: Cotton – Industrial Results

Seed cotton composition	
Lint Income	38%
Pit Income	53%
Impurities	6.5%
Fiber	2.5%
Cotton pit composition	
Seed oil	15.2%
Linter residual	12.5%
Linter	7%
Dry waste	46.7%
Peel	20.7%
Residuals	4.9%
Oil	
Biodiesel Density(Kg/L)	0.88
Oil / biodiesel conversion rate	98%

Source:PENSA based on Cotton Products Unit of Aboissa Vegetable Oils and on Cotton gin unit, oil extractor units and Biodiesel plants professionals.

Table 10 brings the products prices used on this study. They represent the historical average price on markets close to the São Francisco valley. The price given to the lint cotton was obtained from Bahia Secretary of Agriculture, Irrigation and Land Reform (SEAGRI) and refers to the week average price from January,2006 to December, 2008 on the city of Barreiras (Bahia). Biodiesel price represents the average price obtained on the first eleven auctions done by the National Petroleum Agency (ANP). The prices given to the remaining products were obtained from monthly average prices from September 2006 to July 2008, provided by Aboissa Vegetable Oil

Table 10: Income factors

Product	**Unit**	**Price**
Lint	Arroba*	R$ 39.97
Pit	Ton	R$ 292.65
Fiber	Arroba	R$ 15.83
Dry Waste	Ton	R$ 521.74
Crude Oil	Ton	R$ 1,329.96
Línter (1st cut)	Ton	R$ 904.84
Crude Glycerin	Ton	R$ 141.67
Biodiesel	Liter	R$ 2.13

*Arroba=15Kg
Fonte: PENSA based on Seagri, Aboissa and ANP.

5.3.2. Investments and Operational Costs

The main on farm investment is the acquisition of the drip system irrigation, estimated on R$ 6,800 per hectare, according to Netafim. Another investment considered on this study is on the opening of the agricultural area with less demanding cultures, which is a necessary technique in order to plant cotton on new lands. For the first year, soy bean was the culture adopted, demanding an estimated investment of R$ 1,571.47 per hectare.

Regarding the production costs, the source for the calculation of costs on the agricultural division of the anchor company was the Brazilian Agriculture Annual (Agranual, 2008), published by the FNP Institute and refers to the irrigated cotton production (160 days cycle) using center pivot irrigation in Bahia State. Thus, the data was adjusted according to Netafim experiments for irrigation conditions using the drip system and the input prices were updated after interviews with west Bahia producers. For the research on operational costs of the integrated cotton producer, it was based on data from Embrapa Agropecuaria Oeste for the 2008/2009 harvest on Itaquiraí (Mato Grosso do Sul), where the small producers are predominant and the mechanized operations are done by a third part (RICHETTI, 2008). Table 11 separates agricultural costs by hectare for the anchor company and for the integrated producer.

Table 11: Agricultural Operational Costs

	Cotton		**Corn**
Operations / Activities	**Anchor**	**Integrated**	**All**
A.1. Soil maintenance	R$ -	R$ -	R$ 15.08
A.2. Soil preparation	R$ 124.01	R$ 165.00	R$ -
A.3. Planting	R$ 72.23	R$ 145.77	R$ 75.76
A.4. Culture Care	R$ 505.41	R$ 248.10	R$ 56.09
A.5. Harvest	R$ 411.70	R$ 480.00	R$ 80.64
A.6. Irrigation	R$ 442.45	R$ 442.45	R$ 442.45
B.1. Fertilizers	R$ 1,524.29	R$ 418.50	R$ 411.60
B.2. Seeds	R$ 97.30	R$ 91.77	R$ 169.00
B.3. Pesticides	R$ 1,448.45	R$ 175.00	R$ 105.88
B.4. Other inputs used	R$ -	R$ -	R$ -
C – Administration	R$ 68.28	R$ 52.14	R$ 89.29
D – Post-harvesting	R$ 884.00	R$ 442.00	R$ 181.37
Operational Costs(R$/ha)	R$ 5,578.13	R$ 2,660.73	R$ 1,627.16
Operational Costs (R$/Arroba* of cotton lint and corn bag)	R$ 36.70	R$ 35.01	R$ 20.77

*Arroba=15Kg

Source: PENSA based on Agrianual, Embrapa Agropecuária Oeste and interviews with west Bahia producers.

The investment needs were obtained with the main capital goods industries, inside their respective sectors, and regarding their productive capacity. These investments are: (a) 30 bales/hour Busa cotton gin (R$ 5.3 million); (b) 100 ton/day Tec Bio Extractor and de-lintering (R$ 6.7 million); and (c) 10 ton/hour TecBio biodiesel plant (R$ 2.6 million). The operational costs of each one of these divisions are represented on table 12.

Table 12: Operational costs of industrial divisions

Phase	**Unit**	**Cost**
Seed remover*	Bale	R$ 4.00
Extractor	Tons of seeds	R$ 19.52
Biodiesel plant	Liter of biodiesel	R$ 0.30

Source: PENSA based on Busa and Tecbio data.

*transport included.

5.3.3. Economical and financial results

Next, the financial results from the agents of different businesses involved, such as agricultural production, cotton ginning, oil extracting and biodiesel production, are presented. Initially, these are analyzed individually and, later, on a more integrated manner.

For the cotton production on Pontal Projects´s 8,000 hectares, a simulation was made where 100 family producers were settled on 25% of the area, whereas the rest of the production would be under the anchor company's control (represented here by only one producer). By doing so, each one of the 100 families would sow on 20 hectares and the big producer would sow on 6,000 hectares. Table 13 brings Internal Results Rate (TIR) and Net Value (VLP) simulations for a single family producer and for the bif producer. To the first, simulation considers the financing of all investments with Banco do Nordeste at a rate of 3.19% per year. Whereas the big producer would finance half of the investments on planting and irrigation, also with Banco do Nordeste, but at a rate of 4.20% per year. On both cases there is a 4 year break for repayments and a 12 year term.

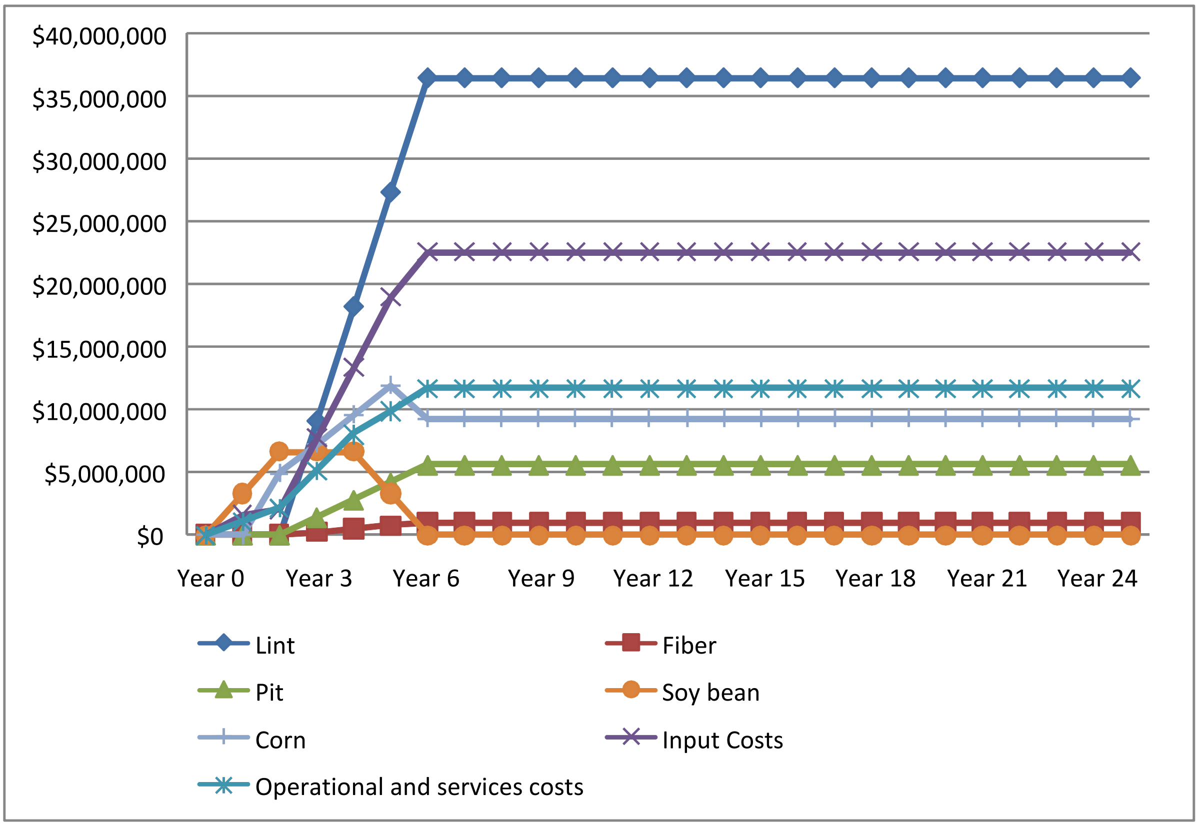
Table 13: Agricultural Business

Agents	Share	Investment	TIR	VPL
Small Producer	0.25%	R$ 164,904.50	14%	R$ 18,346.70
Big Producer	75%	R$ 57,290,449.54	13.6%	R$ 4,999,284.94

Source: PENSA.

For the integrated producer, it is also interesting to analyze the average income. Results show an annual average income of R$ 12,372.56.

Graphic 1 brings revenues versus costs for the anchor company's production. After the first year of investments (year 0), the first revenue comes from the opening cultures (soy bean and corn). On years 1 and 2, soy bean sales correspond to most of the incomes. As the soy bean area is taken over by corn, the last one gains importance, with a bigger share on the income than the former culture by the year 3, when the revenues from the cotton lint becomes more relevant. From the year 6 on, there is no longer soy bean production and the revenues coming from corn and cotton products stabilize.



Graphic 1: Cotton Production - Revenues x costs (R$)
Source: PENSA.

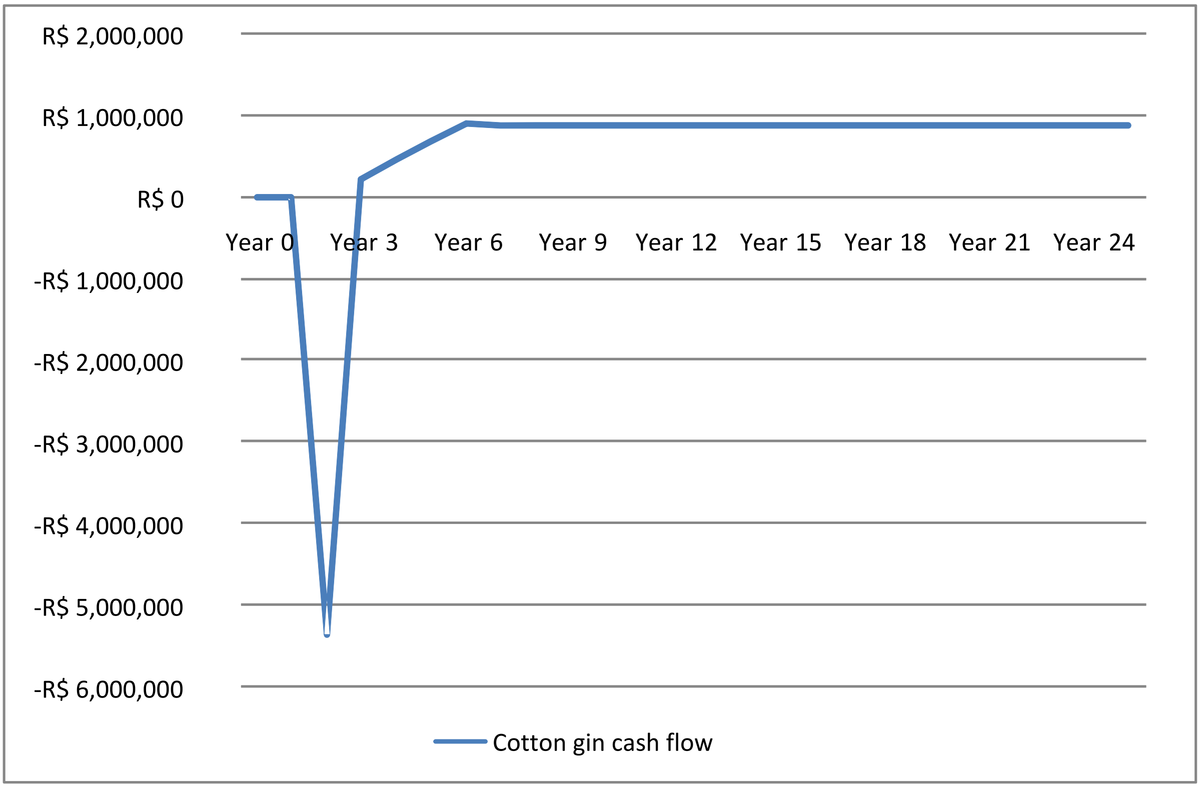
Cotton ginning business is considered here under the big producer's control solely. Thus, regarding the agricultural production, the necessary investments for this business are 50% financed, at a 4.71/year rate and the same term and conditions.

Table 14: Cotton ginning business

Agents	Share	Investment	TIR	VPL
Big producer	100%	R$ 5,350,000	13%	R$ 1,543,545.58

Source: PENSA.

Besides the high costs of processing (45% of annual results distribution) considering the revenues provided by the seed removing service (53%), cotton ginning business is noted by a big initial investment. Since the first three years are dedicated to the opening and formation of the agricultural area, the investment is due year 2 of the simulation. Cash flow stabilizes over R$ 880,000 after year 7 (Graphic 2).



Graphic 2: Cotton gin – cash flow (R$)
Source: PENSA.

The model, thus, integrates the big producer production (75%) and the cotton ginning business. Thus, this producer can process all its cotton at a cost price. On the other hand, the cotton gin, now its property, can only count on the small producer's cotton processing revenues (25%). The results of this integration are presented on table 15.

Table 15: Integrated business

Agents	Share	Investient	TIR	VPL
Big producer	100%	R$ 62,640,449.54	10.5%	R$ 6,492,431.06

Source: PENSA.

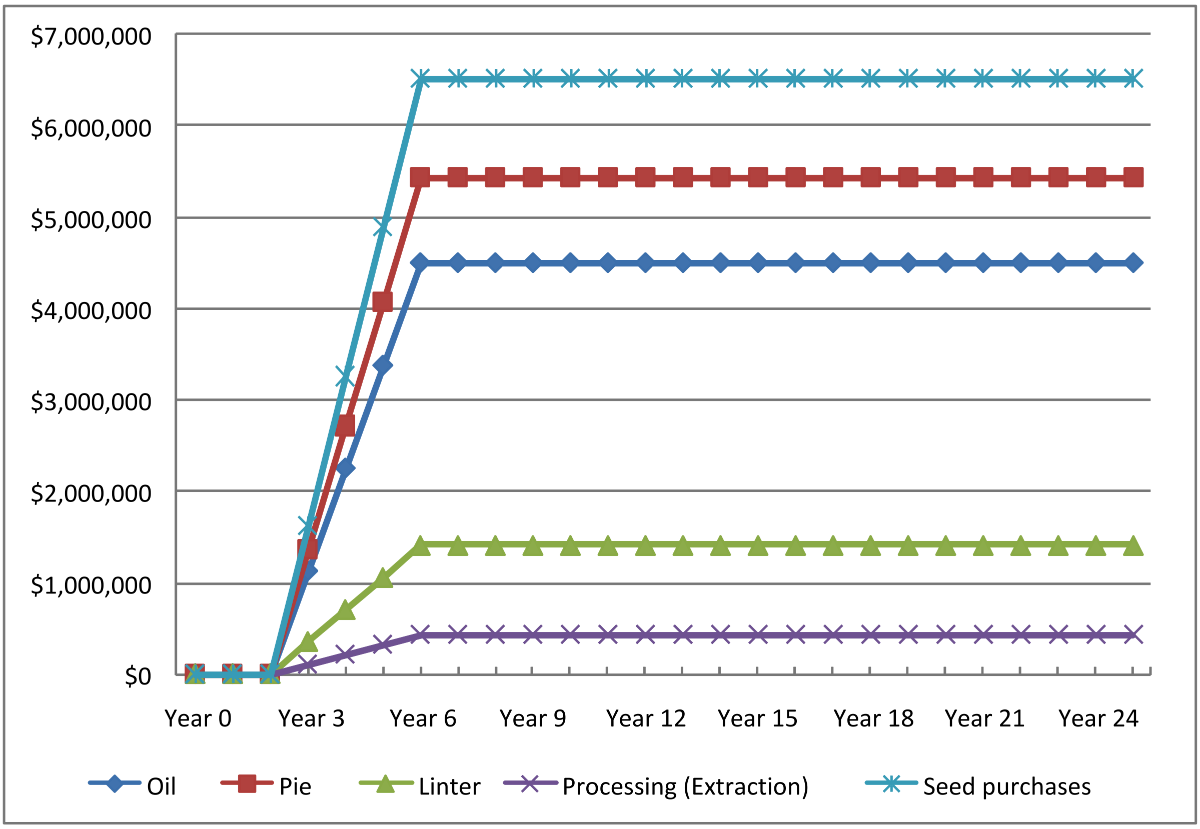
As seen on the business model description, during the oil extraction and biodiesel production phases we have two new agents: a cooperative or trading and an investment fund. These two phases are also financed alike the cotton gin: 50% of the financing, at 4.71%/year on a 12 year term, with a 4 year break. Table 16 illustrates the results of these two phases.

Table 16: Oil extracting business

Agents	Share	Investment	TIR	VPL
Cooperatives/ trading	51%	R$ 3,410,421	36.9%	R$ 8,100,049.09
Investment funds	49%	R$ 3,276,679	36.9%	R$ 7,782,400.11

Source: PENSA.

Cotton pit oil extraction is extremely attractive due, specially, the recent valorization of the oil and the cotton pie and, on a smaller scale, the linter. This way, even with the elevated prices of cotton seed, the extracting unit runs a very attractive business. Graphic 3 brings revenues versus cotton seed oil extraction costs.



Graphic 3: Cotton seed oil extraction – Revenue x costs (R$)
Source: PENSA.

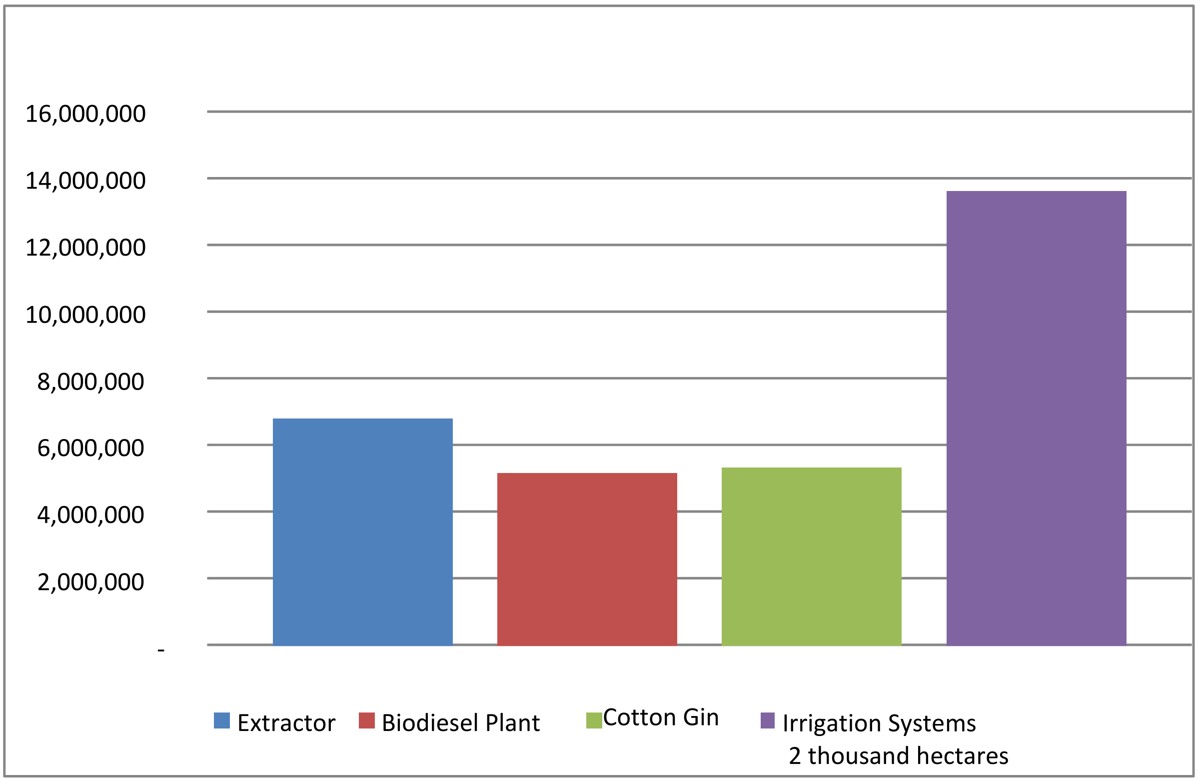
Alike the extractor unit, Biodiesel plant also presents a high Internal Results Rate (TIR). Its structure follows oil extractor's, with the same agents and funding conditions (table 17).

Table 17: Biodiesel plant business

Agents	Share	Investment	TIR	VPL
Cooperatives/ trading	51%	R$ 2,638,716.63	28.9%	R$ 4,152,625.68
investment Funds	49%	R$ 2,535,237.55	28.9%	R$ 3,989,777.62

Source: PENSA.

Besides the recovering on the biodiesel price, the low investment on the industrial plant explains the good performance. Graphic 4 compares the necessary investments on each one of the analyzed businesses.



Graphic 4: Investment Composition (R$)
Source: PENSA.

The analysis of the oil extraction and biodiesel production businesses is done on an integrated form on table 18.

Table 18: Integrated business

Agents	Share	Investment	TIR	VPL
Cooperatives/trading	51%	R$ 2,638,716.63	26.4%	R$ 7,876,178.20
Investment Funds	49%	R$ 2,535,237.55	26.4%	R$ 7,567,308.46

Source: PENSA.

6. Conclusion

In order to make an investment according to the PINS model on São Francisco and Parnaíba valleys, the first phase is the direct contact with CODEVASF expressing an interest. The institution, then, will offer support and orientation for the necessary phases that follow in order to consolidate the entrepreneurship. These phases will necessarily deal with:

1. *Business plan customizing for the company*: on this phase, the economical-financial viability model developed for the project is adapted according to parameters, conditions and scenarios the potential investor might find pertinent.

2. *Negotiation of a special funding package:* on this phase a detailed analysis is done together with Banco do Nordeste (BNB), Banco do Brasil (BB), BNDES and Pronaf (MDA) for family producers and for the anchor company, according to the business plan elaborated.
3. *Definition of available areas on the Public Perimeters of Irrigation (PPI) and/or grant to use the land on new PPI areas:* delimitation of areas where the business could be implemented.
4. *Introduction of an integration model*: the conditions for cooperative integration are agreed, as well as the percentage and responsibilities share of each part on the anchor-cooperative relation.
5. *Contact with input, machinery, equipments and installations suppliers:* budget and negotiations confirmation for the beginning of works. CODEVASF can help regarding business-to-business conditions
6. *Definition of the investment schedule:* on this important phase destined to the coordination of actions until investment matures.
7. *Selection of families to be integrated on the production*: It should follow anchor company criteria and have CODEVASF assistance
8. *Definition of contracts and payments models:* previously to every investment, contracts for the purchasing of the cooperative member production, for the formula for the fiber, pit and other by products price adjustments, for the futures contract sales for the distribution channel and other contractual adjustments.
9. *Investment coordination and execution*: aimed to the area opening (soybean and corn) and done on the first sowings (cotton and corn) and on the building of extraction and biodiesel production plants.

Thus, for the interested investors, it is strongly recommended the contact with public and private agents involved with the development of São Francisco and Parnaíba Valleys. Besides, visiting the region would be very clarifying.

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