

**CHAPTER 4**

BIOFUEL COSTS  
AND  
PRICE FORMATION

As part of the economic analysis of the biofuel chain in Colombia, there are those factors that determine both costs and prices within the industry. This section reviews contractual agreements and formulas that explain the role of the feedstock producer, transformation agent, and commercial trader.

## 4.1 BIOFUEL PRODUCTION COSTS

Costs in any agricultural-based chain or product development will depend on several factors:

- price of land,
- labor wages,
- technological level,
- domestic capabilities to provide proper equipment, and others.

At a global level, those biofuel processing nations that are at the forefront of development and production have proven to be quite efficient in their processes and the cost of production, and have exhibited remarkable results. For example, biodiesel in the case of Malaysia and Indonesia, and sugarcane-based ethanol in the case of Brazil, noted as follows: “The US, the 2nd leading ethanol producer in the world, has variable costs of production of corn-based ethanol of US\$0.96 per gallon. Fixed costs range from US\$1.05 to US\$3.00 per gallon. While in Brazil the total cost of production was approximately US\$1.10 per gallon during the 2005 crop year, with variable costs of US\$.89 per gallon and fixed costs of US\$.21 per gallon” (Martines–Filho, Burnquist, & Vian, 2006).

Such very competitive costs are not the outcome of a sudden set of conditions, but on the contrary, come from the implementation of long-run strategy. In fact, it is reported that by 1980, at the beginning of the PROALCOOL program the production cost in Brazil was near to US\$100/barrel, i.e. between US\$2.7 and US\$3.2 per gallon (José Goldemberg, Coelho, Nastari, & Lucon, 2004).

### 4.1.1 Palm oil biodiesel cost

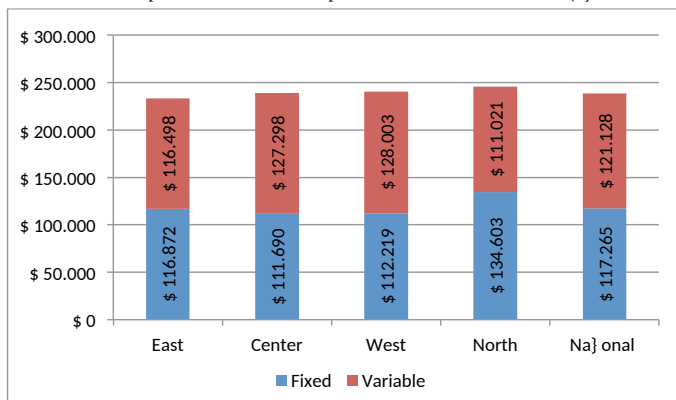
In the case of biodiesel there is a wide range of results regarding the chosen feedstock as is shown in Hass and his team’s study: “Calculated production costs (which included the cost of the feedstock and of its conversion to biodiesel) ranged from US\$0.30/1

(\$1.14/gal) for fuel produced from soybeans to US\$0.69/l (\$2.62/gal) when rapeseed was the feedstock” (Haas, McAloon, Yee, & Foglia, 2006).

Compared with these experiences, Colombia must overcome several barriers in order to mature its ongoing biofuel industry in this competitive market. Among them, is the excessive labor cost. In fact, by 2010 the regular wage for an agricultural worker went up to US\$13 (for a normal shift), whereas in other tropical regions around the globe (like Indonesia), it is possible to find shift payment under US\$5/day. These incredibly low costs are due to workers from other poorer nations being introduced to gain cheap productivity.

There are several studies and estimations that provide an insight to the costs of production of palm oil in Colombia. Some of these studies include comparisons with the international references mentioned above. Despite the closest reference in regional terms would be to the Argentinian figures, it is not as profitable when compared to the South East Asian countries, given that Argentina has its strength in soybean production, while the SE Asian countries and Colombia have a palm-based biodiesel industry, and also share similar climate conditions.

Figure 4.I. Palm oil production cost composition in Colombia 2007 (by zones, COP\$)



Compiled by the author. Data source: Fedepalma website

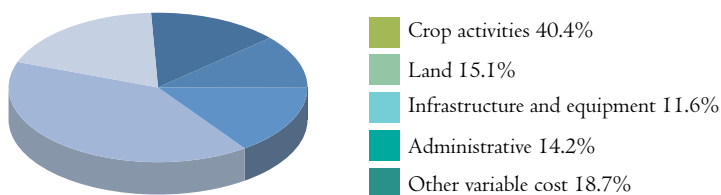
The main component of the cost of Biodiesel is the cost of feedstock itself and in this case, it would be used the vegetable oil, as price floor. According to some calculations, the cost of producing palm oil in 2006 was US\$ 482 per ton (in the Eastern region of Colombia). The exchange rate was close to COP\$2500 per dollar and if it had dropped by 20% (COP\$2000/US\$) the cost would have grown by 25% (Infante & Tobrn, 2010). When checking other sources of information, such costs have been

underestimated: FEDEPALMA has published data for the same year, and by using the actual exchange rate of COP\$2387.58, showed a cost of US\$536.16/ton (at a constant prices for 2007), which gives a more accurate calculation. In fact, during 2007 the national average cost was COP\$1,285,014, but with an exchange rate of COP\$20078.35 per dollar, it resulted in a production cost US\$618.29.

The most important thing in an analysis of this sort is following the relative evolution of the cost rather than establishing such costs in absolute value. This means that a break down on the data into fixed and variable costs might boost the performance of the industry, as it is presented in the figure 4.I.

In particular, the zone with the lowest cost is the Eastern region of Colombia, and here variable and fixed costs are evenly distributed. On the contrary, the Northern region exhibits the highest cost of all, but here, just as in the Eastern region, costs are uniform (nearly 50/50 in both cases). The difference among regions is not substantial at all. By 2007 the gap in cost was close to US\$6 per ton.

Figure 4.2. Average Conformation of palm oil production costs (2007)



Compiled by the author. Data source: Fedepalma website

Compiled by the author. Data source: Fedepalma website Another deconstruction of cost is given by the data provided by Fedepalma in its website, where it is established that the main part (more than 55%) of these costs can be explained by agricultural activity if both land acquisition or leasing, and tasks related with the crop management itself, are included.

### Palm oil fruit price

Price structuring in the case of Colombia, for the palm industry was presented and accepted several years ago, so the benefits of the agricultural process must be shared between farmers and processing plant owners. The scheme is based on the foundation of shared risk, thus the payment on the palm fruit would be in accordance to the amount of oil obtained from each ton of fruit.

The extraction rate can fluctuate significantly from one processing plant to the other, or changes can be noticed among different plantations, depending on the palm variety and harvesting conditions. Nonetheless, in most cases rural farmers receive between 60% and 78% on the extraction rate, and the remaining fraction goes to the processing plant owners.

There are various factors that determine to what extent the percentage can be increased that goes to the farmer, as is explained below:

- Crop age, because yield varies according to the stage of the life cycle.
- Quality of the product, understood as the percentage of the oil contained in the palm fruit
- Degree of competition within a limited zone
- logistic expenditures

The existence of contracts in the palm fruit industry is infrequent, thus in some cases negotiations take place under informal arrangements. However, when contracts do exist, they must specify parameters for:

- the conditions of fruit reception and delivery,
- terms of price settings and distribution,
- regular payment timing conditions,
- and supply exclusivity commitments with some of the available extraction plants (López, 2000).

Within these contracts it also must also be clear that some of valuable agricultural wastes, such as the empty fruit husks belong to the farmer and must be returned by the plant processing owner. If the owner states otherwise, compensation must be offered to the farmer to offset this loss (Hurtado & Hernández-Salazar, 2010). This sort of waste has turned into a quite interesting by-product with a high content of moisture and nutrients. With a simple procedure it can be easily transformed into natural fertilizer. Besides, it seems that this by-product has the potential to be used as feedstock for cellulosic bio-ethanol.

Taking into account that the job of the farmer is to produce as many palm fruits as possible, with the highest oil content as possible, while the plant owners should extract

as much oil as conditions allow, it seems that the described payment method for palm oil is a good foundation to transfer proper incentives to the different links in the chain. However, there is a factor that needs to be solved to seek standard fares – each processing plant must report the accurate measurement of the oil content of processed fruits, so they do not have to follow regional average productivity indexes that are employed nowadays.

In order to move forward into better and stronger relationships, it is important to formalize links between the stakeholders, or at least between direct parties within the processing palm chain, by adopting models of contract that specify commercial, technical, economic and legal aspects, eliminating uncertainty and gaining trust and stability for each party (López, 2000).

The palm sector relies a Price Stabilization Fund (PSF), which determines the price of crude palm oil, therefore, this price is the most common used as a reference for those sales between farmers and extraction plants (García, 2008). This fund acts as an income stabilization agent for palm oil and kernel oil producers, throughout compensations and transfers in function of international prices of these products and their substitutes.

The reference domestic price for palm oil is built upon the base of the international price of this product, or its substitutes, plus tariffs and logistic expenditures (such as freight and port charges). The reference price then turns into an import parity price.

The reference international price (when the product is exported overseas) is calculated based on the regular international price, minus freight charges (from Colombia to abroad) and export expenditures. In this way the external reference price is an indicator of the FOB price for national production.

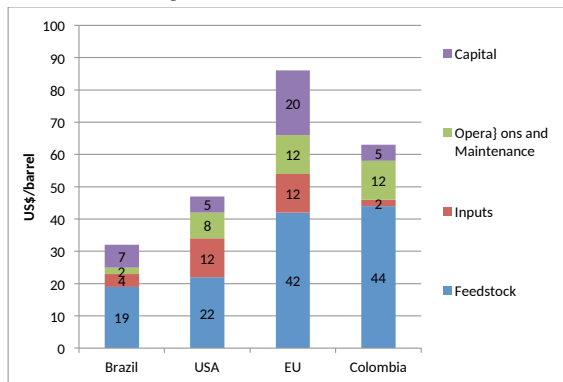
The PSF mandates transfers when the international price is above the reference price, and uses compensations when the international price is below the reference price. Under this procedure the PSF looks to stabilize the average income for agricultural producers, based on their sales to markets that have different prices and profitability.

Given that reference prices are established by the PSF for a 30–days period and the information is provided in advance, it is possible for crude oil producers to inform their providers almost immediately of such adjustments. In this way, Fund's operations have a direct effect over the income that is perceived by the producers, i.e. the payment of the palm fruit.

## 4.1.2 Sugarcane – based ethanol

The competitiveness of Colombian biofuel prices has not reached international standards, as seen by the ethanol prices – by 2006 a barrel of bio-ethanol using sugarcane produced in Brazil cost US\$32. The same amount, using corn in the USA reached US\$47 and in the EU using beet US\$86 (Tokgoz & Eloheid, 2006; Von Braun & Pachauri, 2006). In Colombia a barrel of ethanol costs US\$63. The cost of feedstock only, in the Colombian case (US\$44), exceeds the total cost of Brazilian ethanol and nearly matches the American one (Infante & Tobón, 2010). Feedstock takes nearly 70% of the total cost in the Colombian example, and while it is the largest component of the final cost for every country, it is only against the Brazilian case where the gap is not that wide (in percentage terms, although in fact it is the wider in absolute terms) See graph below.

Figure 4.3. Production cost composition for a barrel of ethanol in different countries (2006)



Note: In Brazil and Colombia ethanol production is sugarcane-based, whereas in USA and EU main feedstocks are corn and beet respectively. Source: (Infante & Tobón, 2010)

The Americans have experienced a more volatile path than the other producers involved in the graph. In 2008 the price of corn soared drastically, and so did the price of ethanol, touching nearly US\$85 per barrel.

Situations like that, of course, favor Colombian competitiveness, but at the same time also benefit direct competitors like Brazil, or any other sugarcane-based ethanol producer<sup>1</sup>. A way to improve attractiveness to international markets is to drop prices via capital investment, i.e. machinery acquisition and technological conversion. However, a choice

<sup>1</sup>The data provided in Figure I5 can only be supplied for the year 2006; more recent data do not appear to be available. The tendency for costs of production to come down is widely recognized and discussed for example in van den Wall-Bake et al (2009).

of that nature is highly sensitive and, in point of fact, possesses a negative effect in terms of job creation.

In the Cauca river valley region of Colombia, sugarcane yield is close to 120 tons/ha/year (FAOSTAT, 2011). This amount is cut manually at a rate of 3 tons per daily shift. That would imply that by introducing heavy machinery for cutting purposes they can replace approximately 40 shifts per hectare every year. Furthermore, each cutting machine is able to process nearly 250 tons of cane per day (C.A. Ramírez Triana, 2011).

Using simple math on the case of Cauca valley, we know it has approximately 200 thousand hectares for sugarcane plantation; hence it is possible to produce 24 million tons per annum. If cane were to be entirely cut by modern equipment, in a year it could produce 91,250 tons by one single machine working every day. Under this assumption it would be necessary to employ 264 machines per year to fully harvest these crops. On the other hand, if it is assumed that such machinery is able to replace labor completely, then around 8 million shifts will be lost.

In summary, despite the fact technological conversion could provide a good financial solution for the issue of competitiveness, it represents a high social threat, therefore, it is vital to explore other alternatives in order to reduce cost per unit.

One possible alternative is the introduction of precision agriculture, given that it could enhance productivity and reduce economic losses and environmental impacts through technology (Bongiovanni & Lowenberg-DeBoer, 2004; McBratney, Whelan, Ancev, & Bouma, 2005). Another possibility rests on the fact that transport and storage infrastructure requires update and improvement. There are some regions where the use of pipelines is a better choice than the regular road transport method; however, such decisions require mutual agreement between the government and sugar industry representatives.

### Price for sugarcane

In the sugar industry, just like in the palm industry, the major players in the chain are the agricultural producers and the manufacturers (or processing plant owners). In order to set a price, what happens in the sugar industry is that farmers deliver or provide sugarcane to the mill or sugar processing plant (also called ingenio), and according to the volume and quality of sucrose, the amount of equivalent sugar kilos is calculated. This is used as floor, and over it distribution starts. The farmer receives 50% of revenue from sales by this material. Price is built as a result of a weighted average, which is calculated taking



into account all sales by the ingenio in every one of its markets. In this way, indirectly, all suppliers (including the small farmers) participate in each of the markets where the ingenio trade (Infante & Tobón, 2010).

Within contracts, it is defined that all kilograms of sugar that have already been paid for by the suppliers are considered delivered, packed in sacks of 50 kilo each, and ready for being shipped to a traditional market. Any additional expenditure that needs to be paid in order to commercialize the product (different to the ones considered for the traditional market), must be assumed by the sugarcane provider and it is deducted from the total payment. Such expenditures take into account those costs to transform crude sugar to white sugar, or refined sugar, or any other form. In fact, bioethanol is judged to be one of these varieties. Some additional charges include:

- logistics and commercialization costs,
- terrestrial and maritime freights,
- warehousing,
- insurances,
- packaging,
- fixed and variable fees from the international trader,
- and the remaining administrative and financial expenditures.

In addition, the price of the contract can be modified by intervention of the Fondo de estabilización del precio del Azúcar —FEPA— (Sugar Price Stabilization Fund), that adjust the processing plants income based on a scheme of retentions and compensations to stabilize incomes to all participants along the sugar processing chain (Prada, 2004).

According to the ongoing legal framework this fund acts as a “Chamber of Compensation”. So, first they set a reference or equilibrium price, then, when the product is sold at a price over the reference one, then the difference is retained by the fund. In a similar way, when sales take place with a price under the reference one, the producer is recompensed with the exact difference between equilibrium and actual price.

In the particular case of the sugar market, FEPA applies its tools to balance the income obtained by each plant individually, based on the average income perceived by the industry as a whole by the sale of sugar and by-products.

By stabilizing prices a constant income is guaranteed for each plant, reducing uncertainty and creating favorable conditions and incentives to supply the domestic market and also

to create surplus for exports. This practice is not unfair in any way – a market like the sugar one, which is highly controlled and subsidized, does not reflect competitive prices in most cases.

The implementation of this scheme is quite similar to the one employed in the sugarcane provision payment contracts explained above. The representative price of each market, which is the adjusting factor for the ingenio’s income, comes from a weighted average of the sales from the entire industry in every one of the markets where their products are traded. This formulation can be expressed as follows:

$$PPP = (Y \cdot PRMT) + (Z \cdot PROM)$$

Where:

- $PPP$  = weighted average price
- $PRMT$  = Representative Price of traditional market
- $PROM$  = weighted average of representative prices of all other markets
- $Z$  = share in those markets different to the traditional
- $Y$  =  $100\% - Z^2$

There are some aspects in the calculation method that need some further explanation.

For export purposes the prices used by the fund are those corresponding to the weighted average of the lowest quality in a given market. The reason why this is the chosen control, is to create an incentive for competition and to foster value creation among the plants owners. The difference between the fund price and the actual sale price affects everyone individually, offering better prices obtained by selling better qualities and by applying processes of added value.

When sales take place within domestic markets, but different to the traditional one, the reference price are the New York price for crude sugar and the London price for white one.

This price intervention mechanism is calculated ex-post, meaning the income for the plant and the industry are assessed once all trade operations have taken place in the sugar

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<sup>2</sup>All the Acronyms are intentionally left in Spanish and are translated in the List of Acronyms. *PRMT* is understood as the price in the domestic market (fixed by the Fund’s board and approved by the Ministry of agriculture), thus *Y* is the share of sales diverted to domestic market, while *Z* corresponds to the share of sales destined to supply foreign markets. International prices are taken from trading processes. Both domestic and foreign prices are presented in Colombian Pesos (COP) per quintal (and hundredweight, which is slightly close to 50kg). A good example of how the information is managed can be found in Prada Owen (Prada Owen, 2004).

markets. Thus FEPA do not intervene inside the markets and do not interfere in the relationships between plants owners and agricultural producers.

The majority of ingenios transfer the effect of the adjustment implemented by the fund to feedstock suppliers; therefore, income for agricultural producer is also affected by FEPA's intervention, and thus proves how important the fund is for all the links along the chain.

### **Sugarcane payment for bioethanol processing**

The mechanism described previously received strong criticism from sugarcane producers, when the ethanol processing plants starting to operate during the last quarter of 2005.

The cause of this clash when plant owners considered that existing contracts already cover the way to handle sugarcane for bioethanol processing, given that this new product belongs to a surplus market and it substitutes exports within crude sugar market. For this reason, there is neither the need to adopt a new way, nor any additional special formula to calculate the price of sugarcane destined exclusively for ethanol production.

Based on this premise, the final price for sugarcane is determined by the technical fact that from one ton it is possible to obtain up to 75 liters of alcohol (67.7 directly from sugar and 7.3 from molasses). According to the contract, molasses belongs to plant owners, so a farmers share is 50% of that biofuel obtained from sugar directly, i.e. 34 liters per each delivered ton of sugarcane. Thus, the payment takes effect using that calculation as a base, but discounting all the commercialization expenditures that were mentioned before. These costs have been measured and they are equivalent to 8 liters of ethanol, therefore after alcohol fuel is sold ingenios offer only 26 liters/ton to the agricultural producer.

Notwithstanding, the sugarcane producers organization PROCANA (Asociación de productores y proveedores de caña de azúcar), consider that this product is destined to cover a national supply of energy, hence it cannot be treated as a mere substitute of the crude sugar exports, despite the fact that it's a derivative of this item. Procañana argues that most of the value content is embedded in the feedstock itself, and they as providers are receiving as payment only 26 liters/ton out of 75, which is barely a third of the whole value. Under this scheme, the entire cost burden is on the feedstock producers' shoulders.

Based on that, their suggestion is to guarantee distribution process in equal parts, i.e. maintaining a 50% rule, but without applying discounts for processing and commercialization activities. By doing this, farmers would increase their income to

44.2%, given that instead of receiving 26 liters/ton they would receive 37.5 liters per ton of sugarcane delivered to the plant under the new scheme.

The lack of agreement on these grounds leads to instability in the relationships between feedstock producers and the processing plant owners, resulting in arguments that in some cases have ended with renegotiation of contracts, or worse, their cancellation. These differences in the criteria of contractual agreement between parties are crucial, especially to review how effective the conflict solution mechanisms are, given that both interpretations share the point that sugarcane productivity must be split into two branches of the productive chain.

Leaving aside the contractual disputes, there are other reasons why this conflict emerges in the particular case of bioethanol production. Alcohol fuel manufacture started in a period where the international price of sugar was particularly high; hence it was clearly unfavorable to compare revenues from sugarcane-based biofuel sales versus the ones that come from pure sugar transactions.

During 2006, payment per ton of sugarcane to those suppliers of bioethanol plants was inferior to those who offer their feedstock for sugar processing, due to a change in relative prices of both products. So, some farmers had the perception that according to the ongoing scheme it was more profitable to use feedstock to produce sugar rather than be manufactured into alcohol fuel. However, the principle problem is not how proportions are determined, but rather, that prices of sugar and ethanol do not always follow the same path, leading to different revenues.

An additional element of divergence is the way discounts are assessed by manufacturers, and similarly, how costs are distributed in the ethanol production process. In order to account for expenditures, ingenios do not apply a standard methodology; instead they come up with formulas and practices of a diverse nature. In some cases, not only are mere operation included, but some financial and reinvestment cost (such as depreciation) are added to the deductions against agricultural producers. These sorts of practices distort the initial idea that is to help the main capital investor (i.e. plant processing owner) to deal with the financial burden of the business. Both feedstock suppliers and manufacturers agree that the bioethanol market as a clear opportunity to heighten their income sources, and to consolidate a developing industry, with a more diversify market. They also agree that preserving good relationships with each other and strengthening links along the productive chain is crucial to provide a good future for the sugar industry, thus offering improved profits for all stakeholders.

## 4.2 CONCLUSIONS

The Biofuel industry in Colombia has not yet achieved international leadership in terms of cost<sup>3</sup>. Based on the information provided by Infante and Tobon, production cost are around 18.2 – 21.5 USD/GJ<sup>4</sup>, while countries like Brazil, Australia and Thailand have reached 14, 21 and 16 (either with sugarcane pressed or molasses) but the initial target is the domestic market, so it can afford the short term poor price management performance, and by the time the industry gains maturity it will be ready for a competitive international market. Feedstock for both alcohol fuel and biodiesel is the most important component in terms of cost structure.

Benefits distribution relies on regulated schemes for ethanol, and unregulated schemes for palm oil. In both cases, Price Stabilization funds act as a reference and somehow show the trend for progress in the near future. As the transformation chain is long, conflicts between feedstock producers and processors are emerging and they need to be addressed in future policy guidelines.

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<sup>3</sup>The SRREN IPCC report shows in its table 2.1 an estimation of production costs that are available for comparison with the Colombian case (Chum et al., 2011).

<sup>4</sup>For calculations it was taken in consideration equivalence of 1 litre of ethanol has between 18.4 and 21.2 MJ/l, i.e. between 2.92 and 3.37 GJ/b.

