System Dynamics and Innovation in Food Networks 2010

Proceedings of the 4th International European Forum on System Dynamics and Innovation in Food Networks, organized by the International Center for Food Chain and Network Research, University of Bonn, Germany
February 08-12 2010, Innsbruck-Igls, Austria
officially endorsed by

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INFITA (Intern. Network for IT in Agric., Food and the Environment)

edited by

M. Fritz, U. Rickert, G. Schiefer

ISBN 978-3-941766-03-7

Investment Decision in Vegetable Oil Extraction Plants in North of Minas Gerais – Brazil: An Application of the Analytic Hierarchy Process in a Biodiesel Production Chain

Aziz Galvão da Silva Júnior, Ronaldo Perez, and Matheus Boratto
Federal University of Viçosa, Rural Economics Department
DER-Campus da UFV, 36570-000 Viçosa-MG, Brazil
aziz@ufv.br

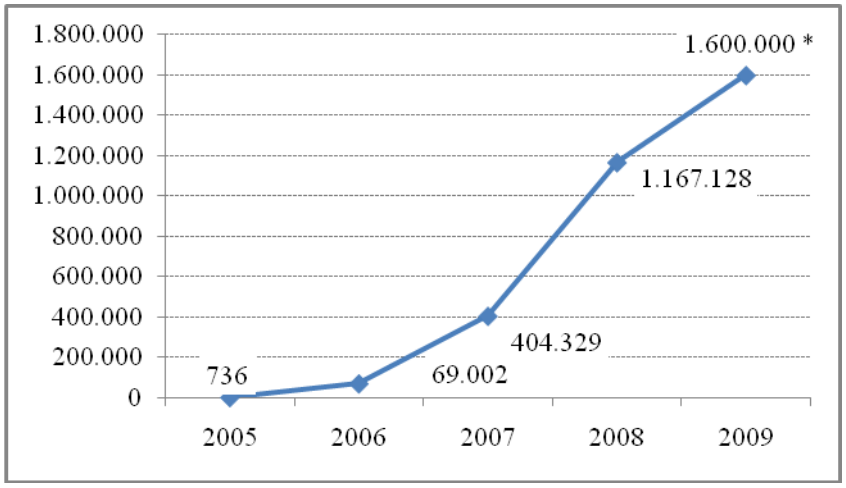
Abstract

In line with the social objectives of the PNPB (Brazilian Program of Production and Use of Biodiesel) and its "Social Seal" Framework, PETROBRAS has set up a 57 million liter/year biodiesel plant in the semi-arid region of North of Minas Gerais State, where the socioeconomics indicators are very unfavorable. Despite the potential to boost the agricultural and agro-industrial sector, the biodiesel plant is using mainly soybean oil from other regions. Funded by the Minas Gerais Government, the ongoing project aims to contribute to the development of oilseed supply chain in the North of Minas Gerais. To deal with these socioeconomic complex decisions, the Analytic Hierarchy Process (AHP) was used. Organization models were proposed for the following production chain: i) castor seed, ii) jatropha, iii) sunflower seed, iv) cotton seed, v) macaw palm and vi) soybean. For each chain, investment alternatives were analysed using the software BiodieselFAO. The organizational models and economic results will be discussed with the stakeholder in a workshop, when the alternatives will be selected. Partial results of the project demonstrate that the lack of trust between the stakeholders is the main challenge to the organization of the production chains. The AHP methodology has been proved to be adequate to accomplish the project objectives. Further researches on production chain modeling and building are, especially for the bioenergy sector, highly opportune.

Keyword: *biodiesel, oil extraction, AHP, North of Minas*

1 Introduction

During the 70s oil crisis, the Brazilian government launched a broad program for substitution of fossil fuel, which included the production of bioethanol from sugar-cane and biodiesel from vegetable oil. Unlike the ProÁlcool (bioethanol), the early biodiesel program known as ProÓleo was soon discontinued. In 2004, the National Program for Production and Use of Biodiesel (PNPB) was re-launched. Its regulation framework was defined by the Law 11.957 from January 2005. From 2005 to 2007 the mixture of biodiesel to diesel was optional to 2% (B2). The mandatory phase has begun in 2008, with the obligatory blend of 2% (B2). It represents a captive market of about 1 billion liter of Biodiesel per year. The government has anticipated the B5 since January 2010. The current installed capacity of the 44 biodiesel plant reaches the volume of about 4 millions m3/year. It is sufficient to supply the current B5 demand. The following picture depicts the evolution of the Brazilian biodiesel production.



* Estimated based on actual figure from Jan to Nov 2009 plus Dez 2009 projection

Figure 1. Yearly Evolution of Biodiesel Production (in m3) in Brazil: Source: ANP

The inclusion of the small scale farmers is an explicit objective of the PNPB. Through the "Biodiesel Social Seal", biodiesel plants can profit from tax incentives and access auctions organised by the Petroleum, Natural Gas and Biofuel National Agency (ANP), who control the biofuels market. In North of Minas Gerais region, the Social Seal requires that a minimum of 30% of the total industry agricultural expenses have to be related to the small scale farming in form of oilseed or vegetable oil purchase, rural advisory service or seed distribution. The Petrobras Montes Claros is one of the 44 industries holding the biodiesel social seal, as indicated with a triangle inside a circle in the following map.

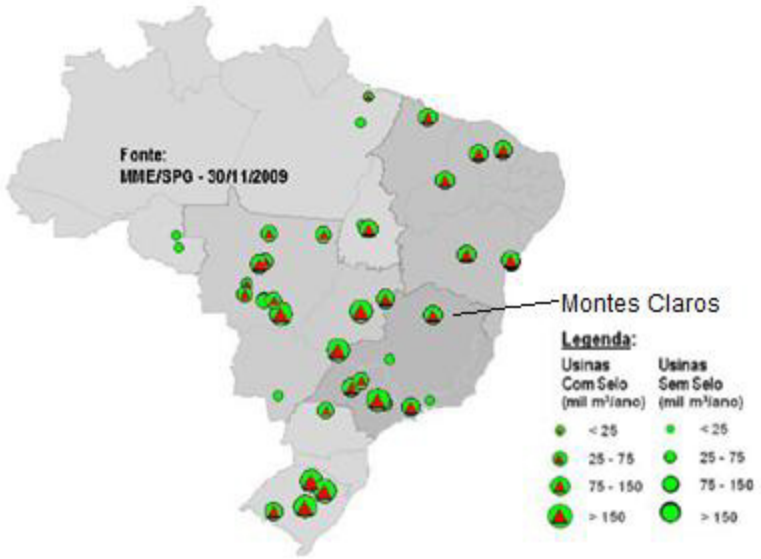


Figure 2. Geographic Distribution of the Biodiesel Production: Source MME/SPG

The Brazilian Petroleum company, PETROBRAS, is a key player in the Brazilian biodiesel sector. It is the large Brazilian company with presence in other 27 countries, 76 thousand employees and a market value of about US$ 200 billion. Although it ranks in the fourth place considering the biodiesel production, the company has a large investment and research capacity to easily reach the leadership of biodiesel market. The company owns three biodiesel plant, located in the semi-arid region of Brazil. The 57 millon liter/year plant located in the

municipality of Montes Claros has the potential to boost the oilseed production in the North of Minas Gerais region, with significant socioeconomic impacts in the agricultural sector.

However, Montes Claros industrial plant is using mainly soybean oil from other regions. Aware of the importance of the biodiesel plant and the challenge imposed by the necessity to increase the oilseed production in the region, Minas Gerais Government, through its Science and Technology Secretary, has initiated a set of actions to organize the supply chain of vegetable oil.

2 Objective

The main objective of the project is to support the actions undertaken by Minas Gerais Government SECTES-MG in boosting the oilseed supply chain in the North of Minas Gerais. Specifically the project aims to:

1) Describe and analyse the current situation of the oilseed production chain in the region;
2) Propose organizational models for selected oilseeds production chains;
3) Identify and select investment alternatives based on stakeholders objectives, organizational model and economic results;
4) Disseminate results to the stakeholders.

3 Methodology

The theoretical reference, on which the project is based, is the concept of the production chain as a system. The production chain can be considered a set of elements, which interact with each other through dynamic links to reach an objective. Silva and Souza Filho (2007) have outlined the historical development of the system approach in the economic analysis of production chain from the input/output in the 50s to the revisited value chain in the 2000s. The importance of the institutions and the transaction costs are incorporate in the New Institutional Economy (NIE) approach proposed by Willianson (Zylberstajn, 1999).

According to Staatz (1997) the main task involved in the production chain analysis are related with:
Describing the current structure of the production chain in terms of activities, actors and rules involved;
Explaining why and how this structure arose;
Analyzing the implications of this structure for the current and future economic performance of the chain.

In order to reach the objective of the project, the Analytic Hierarchy Process (AHP) methodology was selected. The AHP is a decision-making method proposed by the mathematician Thomas Saaty, which has been intensively used by business and governamental organisations. Alphonce (1997), Rozman (2005), Buchholz et al. (2007) and Achabou (2008) present application of AHP models in Agriculture. In a recent project, the AHP was used by the authors of this paper to support decision relating to investments in an oil extraction plant in Brazil (Silva Jr et all, 2009a, Silva Jr et all, 2009b).

According to Saaty “the AHP is about breaking a problem down and then aggregating the solutions of all the sub-problems into a conclusion”. The AHP decomposes a complex multi-factor problem into a hierarchy, where each level is composed of specific elements. The main

objective stays at the top of the hierarchy and the objectives (criteria), sub-objectives (sub-criteria) and alternatives are on following level. The objectives can both be quantitative or qualitative, allowing the AHP to handle complex socioeconomic problems like investment decision. Social, cultural and other non-economic consideration can be taken into account by the decision-making process.

Decision makers are seldom consistent in their judgment with respect to qualitative aspects. The decision-makers inconsistencies can be identified and a consistency ratio calculated, allowing the judgment of the result and indicating that the model should be re-evaluated or discarded (Alphonce, 1997).

The AHP, applying in decision group, can lead to better communication and a clearer understanding among members of a decision-making. The methodology is then especially useful in investment decision, in which the economic results depend on the decision of other enterprise.

Forman (2001) proposes the following steps in AHP analysis:

1. Definition of the problem
    - 1.1 Identification of the problem
    - 1.2 Identification of the objectives and alternatives
    - 1.3 Characterization of the alternatives
2. Elimination of unviable alternatives
    - 2.1 Determination of indispensable criteria (objective)
    - 2.2 Elimination of alternatives
3. Structuring of the decision model in hierarchical form including:
    - 3.1 Main objectives, sub-objectives and Alternatives
    - 3.2. Identification of other participants of the decision process
4. Evaluate the model's elements (pairwise comparisons)
5. Synthesize the judgments and identify the best alternative
6. Examine and verify the suitable decision
7. Document the decision.

In the Norte de Minas project, the task has been conducted by members of the project team through meetings and interviews with the stakeholder.

To carry out the economic analysis, the BiodieselFAO software has been used. The software was developed to the Latin American Office of the Food and Agriculture Organization (FAO) and allows the analysis of oil extraction and biodiesel projects, considering both the agriculture and industrial sectors. (Silva Jr et. All, 2009).

4 Results

In the first phase of the project, meetings were conducted with officials from Minas Gerais Government and consultants from Ministry of Agrarian Development in order to select the potential agricultural production chains. The following criteria were used:

- Historical of production in the region;
- Soil and climate condition;
- Logistic infrastructure (input industry, transport, storage and processing);
- Possibility to use the oil meal as feedstock;
- Oil production of the oleaginous plant per hectare.

Therefore, the following production chains were select:

i) castor seed,
ii) jatropha,
iii) sunflower seed,
iv) cotton seed,
v) macaw palm,
vi) soybean

The region was a traditional producer of castor seed and cotton seed in the 80s and the macaw palm has been wild collected by small scale farmers for years. The Minas Gerais research institution (EPAMIG) has been carrying out researches on Jatropha since the first Brazilian biodiesel program, the ProÓleo in the 80s. Partial results are favorable and the Jatropha seed production is now established in the region. Sunflower seed is a new production chain in the region. Although recent researches for sunflower production results are not conclusive, the potential seems interesting considering the high demand for nutritional meal for the animal production. Soybean is cultivated only in one region (Buritizeiro) and the production follows the pattern of plantations. Therefore, its social impacts will be smaller than the socioeconomic contribution of other chains.

For each production chain analysis, meeting and interviews was carried out with the stakeholders: farmers, farmers co-operative, Municipalities, representatives of Ministry of Agrarian Development, researches institutions and Petrobras.

We will exemplify the project with the cotton seed chain, which has the higher social impact among all production chains. In the 90s the area cultivated with cotton has reached 130 thousand hectares, supplying 30 cotton gin industries. Due to plant attack by insect and the Chinese textile competition, the area was reduced to less than thousand hectares and all cotton gin went bankrupt. Following we present the scheme of one of production chain.

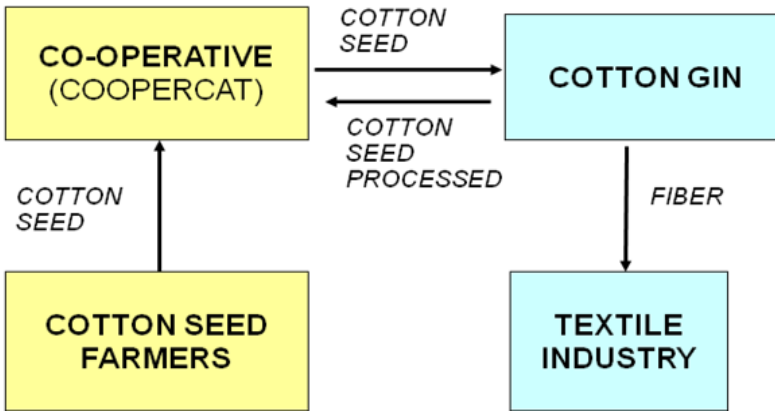


Figure 3. Currently Organizational Model of the Cotton Seed Production hain

The proposed model takes into account the analysis of the chain and the structured interviews with stakeholders: cottonseed farmers, farmer co-operative (Coopercat), cotton gin industry, research organization (Epamig), State advisory service (EMATER), Secretary of Agriculture of the Catuti Municipality and representative from the Initiative "POLO" of the Ministry of Agrarian Development.

The Petrobras Montes Claros, following the requirements of the Biodiesel Social Seal, has created a market for the cotton seed produced by the small scale farmers. A project, sponsored by Monsanto, has introduced in the region a genetically modified variety resistant to the main caterpillar allowing the re-introduction of the cotton seed in the region. This project is coordinated by a well structured co-operative, the Coopercat.

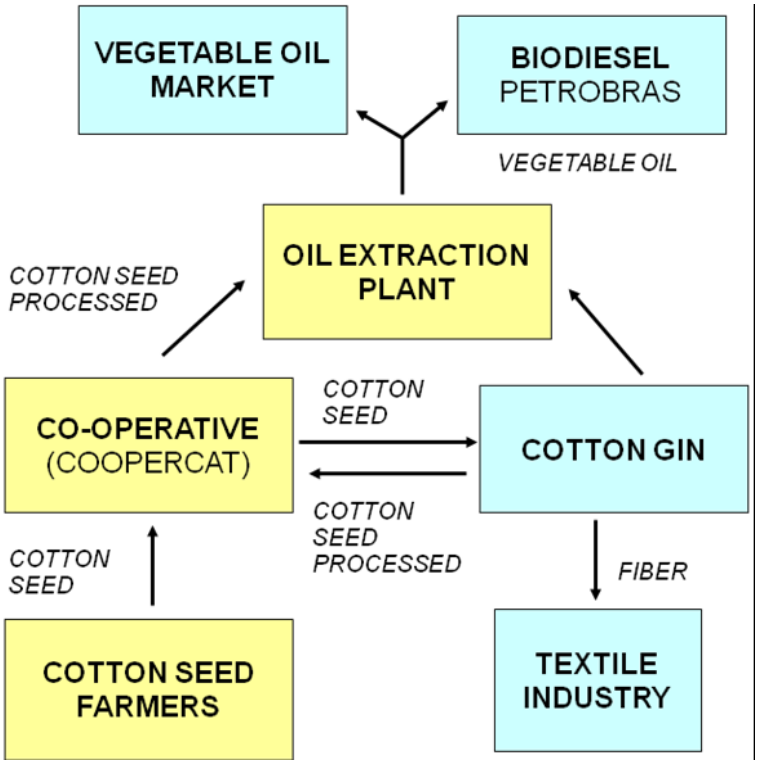


Figure 4. Proposed Organizational Model for the Cotton Seed Production Chain

Based on the identification of chain elements, flow of products, information and the characterization of the market relations, we have defined the problem, objectives and alternatives, as depicted in the following report of the software Expert Choice ®. The appraisal of alternative will be carried out in the next meetings.

Treeview

- **Goal: CHOOSE THE BEST INVESTIMENT ALTERNATIVE (cotton seed)**
  - **ECONOMIC RESULTS (L: ,340)**
    - **higher profit (L: ,789)**
    - **smaller volume of investment (L: ,055)**
    - **smaller payback period (L: ,156)**
  - **GARANTEE OF SUPPLY (L: ,139)**
    - **existence of a contract (L: ,720)**
    - **smaller price volatility (L: ,225)**
    - **smaller volume of stock (L: ,055)**
  - **GARANTEE OF SALES (L: ,181)**
    - **higher utilization of installed capacity (L: ,500)**
    - **garantee of the sales (L: ,427)**
    - **mantening the productive ativicitives (L: ,073)**
  - **STRENGHTEN THE CO-OPERATIVE (L: ,340)**
    - **strenghten the image (L: ,857)**
    - **strenghten the operation (L: ,143)**

Alternatives

DO NOTHING
SET UP COTTON GIN + OIL EXTRATION (SMALL SCALE)
SET UP COTTON GIN + OIL EXTRACTION (MEDIUM SCALLE)
SET UP ONLY COTTON GIN
SET UP ONLY OIL EXTRATION

Figure 5. Structure of the Decision Model for the Cotton Seed Production Chain

Using the software BiodieselFAO, alternatives have been developed for each chain. The sensibility analysis of economic results for one example alternative is shown bellow (SET UP ONLY OIL EXTRACTION). The software allows simulation, which will be conducted during the meeting with stakeholders. The first results indicate the importance of a formal contract (existence of a contract weight 0,720). The AHP is being revised and will be the base for the next phase of AHP, which will be conducted in a workshop with all stakeholders.

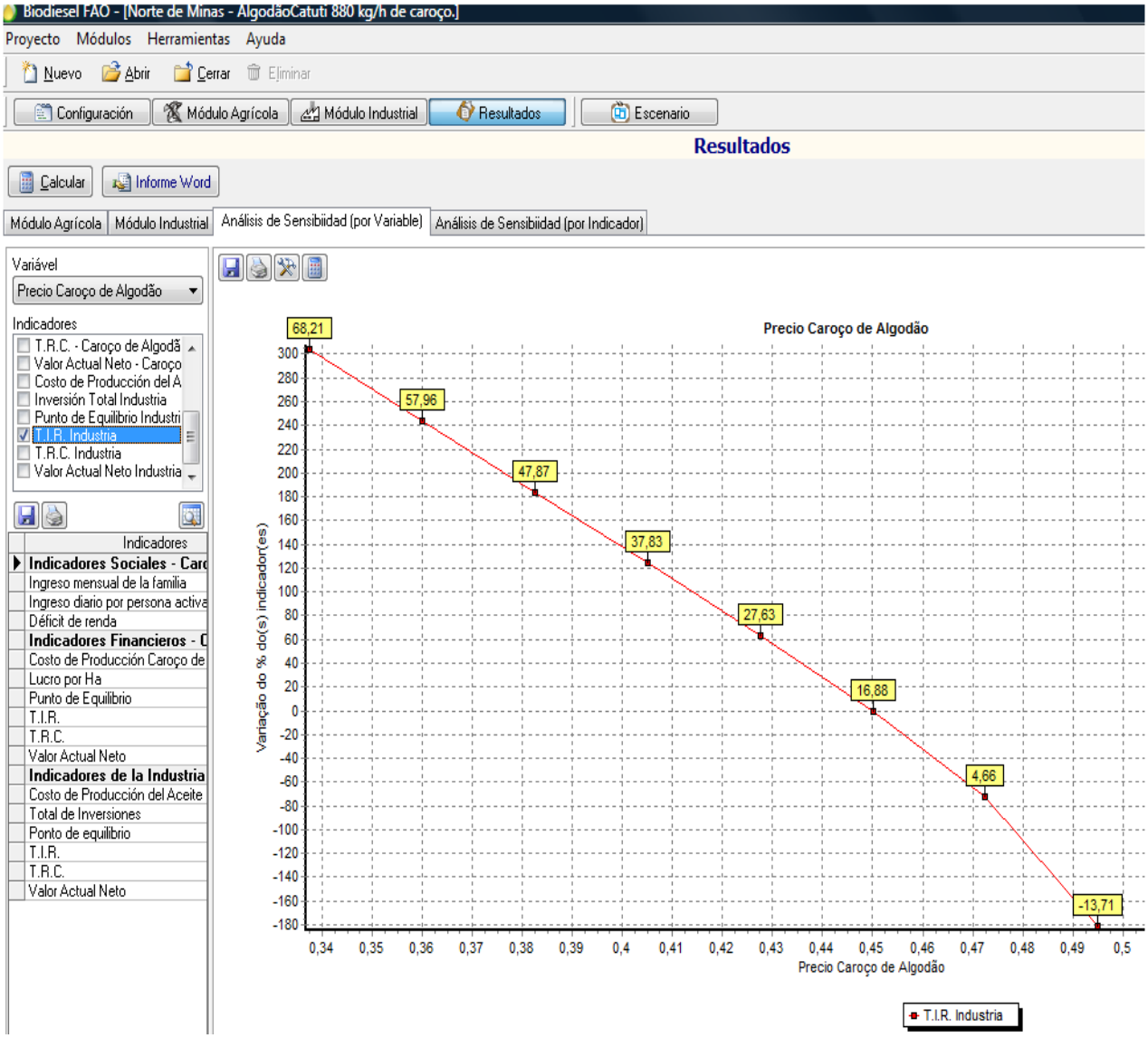


Figure 6. Economical Sensibility Analysis of one Alternative using the Software Biodiesel FAO

5 Conclusions

The Petrobras biodiesel plant in Montes Claros can significantly boost the oilseed production in North of Minas Gerais with important economic and social impacts. The variety of production system is an advantage. Different regions can supply the Petrobras with vegetable for biodiesel and the oil extraction cake can foster the animal production in the North of Minas Gerais with further socioeconomic benefits.

Partial results of the project demonstrate that the distrust between stakeholders is the main challenge to the organization of the production chains. Although primarily not intended to be an instrument of the chain analysis and trust appraisal between commercial partners, the AHP methodology has been proved to be highly adequate in this task.

Further researches on production chain modeling and building are, especially for the bioenergy sector, of utmost importance. The potential of AHP in appraisal individual requirements can be explored in chain organization model and also contribute to avoid failure in chain building.

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