**Study of the economic feasibility for the implementation of a sustainable biorefinery in the production of bioethanol**

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**1. Introduction**

 The preoccupations about climate change and sustainability have driven the exploration of the production of alternative fuels. Bioethanol currently dominates the market and contributes 65% of the world's biofuel production [1, 2]. In this work, the feasibility of obtaining bioethanol from the lignocellulosic biomass in Guanajuato (Mexico) was studied, integrating SWOT tools and sustainability indicators of the reproduced processes into the study, that could be taken as a model in other cases of study at a national or international level under the same perspective.

**2. Methods**

The proposed methodology was divided into three stages: 1. Agricultural zones, 2. Reproducibility of the processes, 3. Analysis of the feasibility. **Agricultural zones (obtaining and quantification of raw material)**. The quantification of residual biomass from corn crops was carried out based on the model obtained by Bentsen [3], in which the waste index (WI) is exponentially proportional to the yield (Y) : WI = a · e b Y , where a = 2656, b = -0.000103 ha· year · kg-1 and yield (Y) is given in units kg · ha-1 · year-1. Waste produced (W) from the production of a certain crop is proportional to the volume produced (V) according to the relation W = V · WI. Following the relation W = P · WI, the expression to estimate the produced volume of waste in kg is: W = V · 2,656 · e-0.000103 Y .To measure the volume of waste from each municipality of the study area, the yield (Y) and production values recorded by the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) [4]. **Reproducibility of the processes**. This was carried out based on the established methodology, figure 1 [5,6].

Figure 1. Scheme of the productive chains for the obtaining of bioethanol [6].

**Analysis of the feasibility.**

The indicators of sustainability were developed as indicated by the methodology of Indicators of Sustainable Development [7]. The SWOT matrix was developed by four types of strategies: strength-opportunity, weakness-opportunity, strength-threat, weakness-threat, that can be raised to convert weaknesses into strengths and threats into opportunities. The analysis of attractiveness was made based on the business template PNESINSO / strategy planning model, Innova Solutions [8]. Based on the results obtained in the three stages, the feasibility of a sustainable biorefinery of the production for bioethanol was analyzed and discussed.

**3. Results and discussion**

The Guanajuato States was divided into geographical farming zones (Figure 2). The map shows the biomass potential within the state of Guanajuato in relation to corn residues ranging from 2,800 + 320 tons / year, representing a high energy potential of the production for biofuels and identifies the municipalities that contribute this biomass. The identification of these municipalities is the first step to evaluate the current availability of biomass and accurately estimate the bioenergy production capacity of waste derived from corn agricultural crops. The reproducibility of the pretreatment and delignification processes was performed to get a way cheaper to feasibility to the economy, that was analyzed base on the SWOT tools (Figure 3), and the sustainability indicators of from reproduced processes (Table 1).The results indicate that bioethanol production cost is 1.65+2.1 USD/gallon and potential production is 60.14 MM gallon/year using corn straw, which indicates that to reduce these costs should be optimized the processes.

Table 1. Indicators of sustainability



Figure 2. The residual corn Figure 3. Graph resulting from the

 biomass potential analysis of the Attractiveness [8].

**4. Conclusions**

The pretreatment represented the stage of greatest cost in the conversion of biomass to ethanol, the investigations are focused on developing pretreatments of delignification, clean technologies and innovation methodologies. However, the cost of a liter of bioethanol is 48% below the current price of gasoline in Mexico. In parallel, the analysis with the tools SWOT and Sustainability Indicators, let us know the project has highly feasible to implement in Mexico, as an alternative to use the agricultural residues had been generated representing a high potential to obtaining new biofuels.

**References**

1. Biofuels Production. [www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewableenergy/biofuels-production.html. Accessed 2 Jun 2017](http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewableenergy/biofuels-production.html.%20Accessed%202%20Jun%202017).
2. Vermuë, M. H., et al. Multi-product microalgae biorefineries: from concept towards reality. Trends in biotechnology 36.2 (2018): 216-227.Bentsen, A. Bianchi, N.C. Jones, Chem. Eng. J. 157 (2019) 326–337.
3. <https://www.gob.mx/agricultura>
4. Muñoz, Alma Hortensia Serafín. Characterization and integrated process of pretreatment and enzymatic hydrolysis of corn straw." Waste and Biomass Valorization 10.7 (2019): 1857-187
5. Cabarcas G. and Serafin Muñoz A., et. al. Prototipo de diseño sustentable para la obtención de biocombustibles bajo el esquema de biorrefinerías." jóvenes en la ciencia 3.2 (2017): 2225-2229.
6. Hák, Tomáš, Svatava Janoušková, and Bedřich Moldan. Sustainable Development Goals: A need for relevant indicators. Ecological Indicators 60 (2016): 565-573.
7. <https://mx.linkedin.com/in/gerardo-pati%C3%B1o-zamudio-8794a451>