Development of a Value Network Based on Bioenergy Management to Determine Business Strategies

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Abstract: Poultry industry identifies an area of opportunity to generate bioenergy by using poultry litter. It is produced at broiler chicken farms and used as biofuel a more technology profitable (anaerobic digestion , codigestion, or direct combustion) is being implemented. The results showed that the variables that most impact to improve quality in the moisture content (wt%) of the poultry litter are handling, extractors, density m^2, external temperature (°C), roof lining, days of stay and fans for improving farming conditions and reduce the percentage moisture content of less than 25%. These variables are used for the development of Artificial Neural Net and Fuzzy Logic model (I.A.), analyze their effectiveness and control the system. By using Monte Carlo Simulation, it is performed a risk analysis that includes the results of all techniques which best economic alternative is the bioenergy generation through direct combustion of dry poultry litter.

Keywords: Bioenergy, Poultry Litter, Anaerobic Digestion, Anaerobic Co-Digestion, Direct Combustion, Artificial Neural Network, Fuzzy Logic.

1 Motivation

Worldwide there are institutions and companies conducting scientific research and technological development of processes, products and services related to bioenergy, reusing residues, waste or co-products produced. In Mexico, in the center of the state of Veracruz, there is an opportunity to determine the energy use of residual biomass generated by different production processes in the poultry agrobusiness and cane-sugar sector that can be transformed allowing energy exchange through a network.

The value network is a business analysis perspective that describes resources within and between businesses, formed by two or more value chains, defined by a sequence of processes, in this case industrial residues or co-products to be used in direct combustion and anaerobic digestion systems to generate steam and bioelectricity, to use the poultry litter as feedstock for its direct combustion in a boiler, you should check the moisture content, to achieve this, it was decided to use artificial neural networks (ANN) and fuzzy logic (FL) to control the production system on broiler poultry farm.

2 Previous Works in the Area

2.1 The Use of the Biomass as Renewable Bioenergy

The waste from agricultural operations represent a potential large volume available for use in the production of electricity from biogas generation using anaerobic digesters and steam from combust biomass (Karaj, 2010), the identification of biomass sources can provide large amounts of released renewable energy (McKendry, 2002-1), the use of biomass combustion creates the need to develop and integrating value chains bioenergy using waste biomass energy sustainably (Taylor, 2008).

2.2 Humidity and Energy Contained in the Poultry Litter

The moisture content in the poultry litter is kept in parameters between 20% and 25% and it is attractive to use it for its combustion (Martin, 2002). The importance of control systems of broiler farms, if the moisture contained in the poultry litter should not exceed 250 grams of water per kilo (Collet, 2012). The direct combustion of poultry litter to produce energy as long as the moisture contained is less than 25% (Kelleher, 2002). The poultry litter if is kept below 25% need not added any other biofuel (Abelha, 2003).

2.3 Technical Application of Artificial Intelligence

An ANN predicts the efficiency of combustion of the poultry litter inside a boiler to allow the prediction of the poultry litter combustion inside the boiler (Zhu et. Al, 2007), using fuzzy logic and neural networks for controlling the system and environmental to increase efficiency (Lee, 2000). Developing a prediction system based on ANN allows to control the parameters of quality in the drying predicting parameters, ANN are useful for optimization and prediction in industrial systems (Chegini, 2008). Minimizing moisture content is worthy of investigation for all combustion techniques and is a factor with controlling for poultry litter as an efficient biofuel (Kelleher, 2002).

3 Hypothesis or Research Objectives

3.1 Hypothesis

Generate business strategies that increase the profitability of value chains forming the network, from of the bioenergetic re-utilization of industrial waste.

3.2 Objective

Develop a network of bioenergy value integrating two or more agribusiness value chains from bioenergetic management of their waste to maximize its economic profitability, and the energy performance from poultry waste and agribusiness.

3.3 Methodology

It aims to strengthen existing methodologies with a scheme of 7 stages of preliminary evaluation to determine the value of exchange negotiable on the bioenergy value network: 1) Control system of waste production. Modeling the control and production process and to determine which variables that affect the system. 2) Quantity and quality of waste. The control variables to determine the products and waste produced. 3) Relative humidity or inhibitor performance. Disabling the factors affecting the quantity and quality of the residue for use as biofuel. 4) Selection to technology for produce bioenergy (kcal) by waste type. 5) Quantity of bioenergy. Determine the useful amount of bioenergy that can produce and exchange. 6) Economic projection, to determined by type of waste and type of bioenergy, and assesses the investment and cash flows of technology. 7) Sustainability. The principal benefits environmental and socials by bioenergy waste reuse.

4 State of the Research

The energy contained in the biomass of agro-industrial waste is an alternative that can be interest to everyone because it is a renewable resource and there are several technologies available for their use and to quantify the potential power generation contained in it, for bioenergy exchange between network integrated companies.

Has been prepared a Artificial Neural Networks using data obtained from the moisture content of poultry litter from the laboratory and statistic data related to the operation of farm equipment and a Fuzzy Logic model with support an expert in the area of poultry is designed, then a comparative analysis of techniques is made, both techniques are used in order to test the effectiveness of each of them to determining the pattern of behavior in the moisture content, the variables that cause the most impact are identified, and finally a comprising a risk analysis model based on Monte Carlo simulation is created in which we examine different scenarios related to the production of poultry litter that include or not its bio transformation through combustion and/or digestion is carried out to determine the economic viability of the poultry litter by exploiting the residue as bioenergy resource in order to facilitate decision-making.

In a subsequent phase will apply genetic algorithms to optimize the system of by waste type production, with the best quality and quantity to maximize the generation of bioenergy.

5 Preliminary Results (or Conclusions)

The ANN and FL models are developed to control the moisture content in the poultry litter, results indicate that the variables the most impact are handling, extractors, density per m2, external temperature (°C). For better quality of poultry litter is required that farms operate within a density from 13.5 to 14.5 m2, the covered with false ceiling or sprayed, that the type of feeder is oval or round, that the number of fans is more than 11 or with the following combinations: 3 extractors and 10 exhaust fans or 4 extractors and 7 fans. Is recommended that employees are trained properly. The other variables can take any value, because it does not represent significant variability affecting moisture results. The risk analysis indicate that the direct combustion for dried poultry litter can replace the use of fuel oil and achieves an income of 45% more compared with the sale in bulk.

The contribution to engineering is the development of a value network model to determine innovative business strategies for the exchange and management of bioenergy, through sustainable use of agro-industrial wastes such as poultry litter, sewage sludge, and agricultural residues harvest cane.

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