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Biomass Energy Potential in Manabí Province

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Abstract

The present work aims to determine the energy potential of biomass in the province of Manabí, having as main actors the residues of cocoa, dry corn, bananas, and African palm, these being the products with the greatest abundance within the province since during Its production is constant throughout the year and this allows it to be used as a base for energy production. The increase in greenhouse gases in the production of consumable electrical energy has led to a significant advance in the development of biologically friendly alternatives. Among these alternatives, one of the options for immediate implementation is obtaining energy through the combustion of conventionally wasted waste, also known as biomass.

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1 Introduction

In the future energy development of the planet, renewable energies are essential for the benefits that their implementation entails (Rodríguez & Vázquez, 2018), in addition to being inexhaustible sources in the life cycle of human beings, they can be used in various forms: in heating, in electrical energy, electrochemistry, among others. These energy sources, in their implementation, have gradually had a social impact by generating jobs, improving the quality of life in remote areas, improving health by reducing pollution; in addition to the levels of knowledge reached not only by professionals, but also the general population. “Biomass is that organic matter of vegetable or animal origin, including organic residues and wastes that can be exploited energetically. Plants transform the radiant energy of the sun into chemical energy through photosynthesis, and part of this energy is stored in the form of organic matter” (biomass, s.f.).

This matter grows exponentially as the population increases worldwide, in other words, the greater the demand, the greater consumption. This is reflected in each production sector and to supply all this demand, it is necessary to further exploit natural resources to obtain the required raw material, which results from multiple processes to which they are subjected and whose effect is to favor environmental pollution. Local development encourages the use of endogenous resources in such a way that this biomass harvested at the site where it is generated can lead to environmental and energy benefits (Vázquez *et al.*, 2019).

As there is a greater consumption of products worldwide, the waste per person increases dramatically, to counteract this problem that affects future generations is to give it an adequate use to mitigate in the same way with environmental pollution, which is why The use of biomass is proposed to generate clean energy sources that solve the two problems: slowing down pollution and satisfying world energy demand. Biomass is an organic matter used as an energy source. Due to its broad definition, biomass encompasses a wide set of organic materials that are characterized by its heterogeneity, both for its origin and its nature. In the energy context, biomass can be considered as organic matter originated in a biological process, spontaneous or provoked, usable as an energy source. These biomass resources can be broadly grouped into agricultural and forestry. Biomass is also considered the organic matter of wastewater and sewage sludge, as well as the organic fraction of urban solid waste (FORSU) and other waste derived from industries (Gregorio, 2018; Posso *et al.*, 2019; Salgado *et al.*, 2020).

2 Materials and Methods

The research method selected for the execution of the work has been the deductive of a transversal nature, as an essential form of reasoning, as well as an object of logic study and research. These concepts allowed analyzing the problem posed to subsequently reach precise conclusions related to the national energy development and to Manabí, where the need to abandon conventional sources and undertake energy sustainability inspired by the optimal use of waste from different agricultural products stands out of energy available territorially. The bibliographic review technique was implemented based on the knowledge of the impacts related to the use of fossil fuels to generate energy and the role of biomass at the global level, as a viable alternative to reduce the environmental consequences derived from energy activity, taking the particular study of the province of Manabí, to carry out the analysis at the national and local levels.

3 Results and Discussions

Bioenergy generation enables energy diversification and can be a transition vehicle towards the use of renewable energy, while it can improve the standard of living of rural communities (Gonzales, 2009). In figure 1, the forms of biomass production are shown.

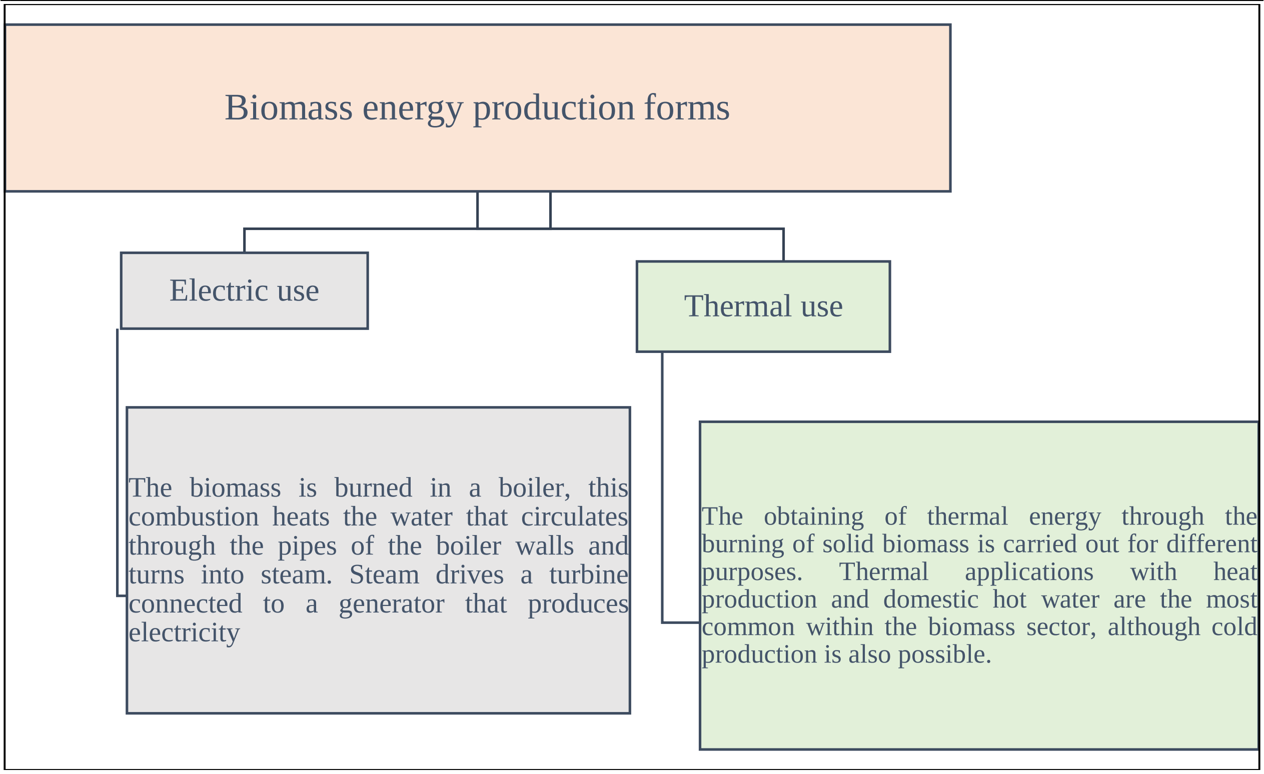

Figura 1. Formas de producción de bioenergía

Biomass boiler

Biomass boilers are compact equipment specifically designed for use, whether domestic in single-family homes, commercial residential buildings, and there are also models for industrial installations. All of them have automatic ignition and regulation systems and even some ash removal systems that facilitate user management. Figure 2 shows the structure of a biomass boiler.

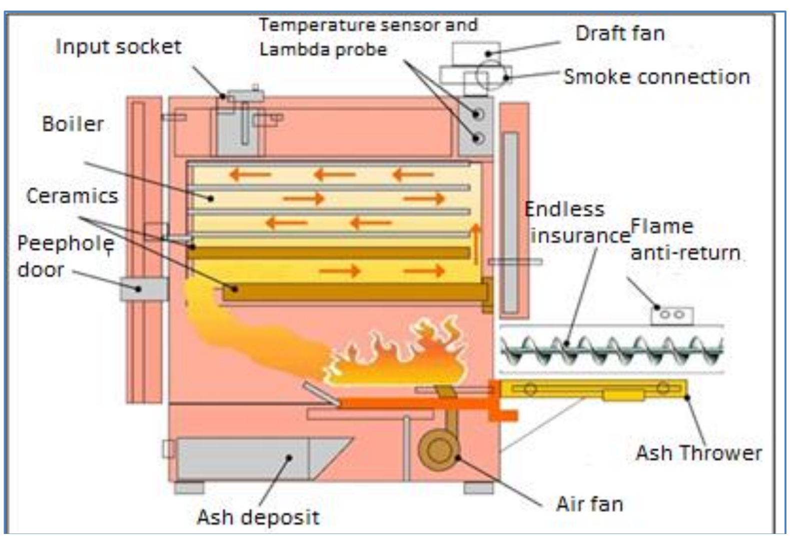

Figure 2. Structure of a biomass boiler

Biomass situation at the international level

Solid biomass is the largest source of renewable energy in the world, by far, due to the existence of traditional biomass in developing countries. It represents 9.2% of the total supply of primary energy in the world, 70.2% of the total supply of renewable energy. 86% of solid biomass is produced and consumed in non-OECD countries. Traditional biomass consists of firewood that is obtained without a commercial transaction, is mainly used for cooking and providing heat in homes, has low levels of efficiency, and generates health problems by emitting polluting gases and particles due to the incomplete combustion of biomass (Santana, 2017). Figure 3 shows some types of biomass internationally.

Figure 3. Types of biomass at the international level

According to the International Energy Agency, in 2009 the total supply of primary energy in the world was 12,169 Mtoe, of which 1,589 Mtoe, that is, 13.1% corresponds to renewable energy. 75.9% of the total supply from renewable sources, that is to say, 1,206 Mtoe, corresponds to bioenergy, according to the following percentages: solid biomass 92.5%, biofuels 4.5%, biogas 1.8% and waste municipal renewable 1.2% (IEA, 2011). In figure 4, corresponding to the prime energy of the planet is observed.

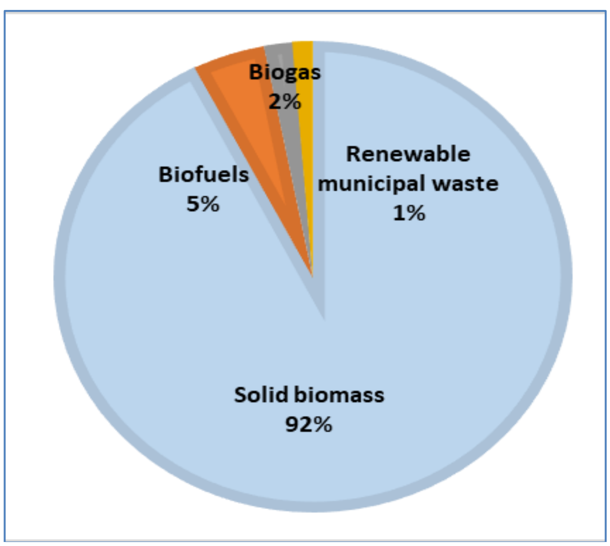

Figure 4. Bioenergy corresponding to the prime energy of the planet

Climate change and the use of renewable energy sources (biomass)

The burning of biomass produces an increase in temperature, reduces overall efficiency. Decreased rains reduce water availability for cooling and production processes. Less water means less growth of corn, soybean, and sugar cane plantations for biofuels.

The crops selected to generate biomass must be highly tolerant to temperature increases and water stress. Consider alternative forms of irrigation such as rain catchment, desalinated water, and water recycling. Efficient irrigation systems such as the drip system (Malta, 2018).

Biomass, another victim of climate change

Heating stands as the main engine for biomass in the world. Generally using boilers, they use natural fuels such as fruit peels, olive pits, or wood pellets. On many occasions it is used to take advantage of organic waste as a substitute for coal and oil (Claire, 2019). The high temperatures registered in recent winters and motivated by climate change led to lower consumption. The result? The paralysis of the growth of this renewable energy, as indicated by EurObserv'ER in its latest barometers.

Biomass in Ecuador

Biomass in Ecuador is very abundant, however, due to being a developing country it is not yet exploited as it should, the most abundant agricultural residues are banana, coffee, cocoa, flowers, corn, rice husks, potatoes, etc. The main current use of biomass in Ecuador is in the production of biofuels that the government is implementing at the national level (Crookes *et al.*, 1997; Kaltschmitt *et al.*, 1997). The demand for gasoline in Ecuador is 20 million barrels per year and 24 million barrels per year of diesel. Since 2010 Ecuador has produced biofuels called Ecopaís, until 2017 the fuel will completely replace the use of the country's second fuel, thus covering 45% of the demand for gasoline throughout Ecuador. Examples of current biomass projects in Ecuador:

a) The National Institute of Energy Efficiency and Renewable Energies (INER), set up a laboratory that analyzes the energy capacity of biomass, especially waste. A technological prototype has been made to produce pellets using the remaining remnants of the pinion as raw material after it has been subjected to a process of obtaining vegetable oil.
b) Corporation for Energy Research has a biofuel plant, it is a gasification plant for residues of African palm, rice, and coffee that produces only 30 kilowatts.
c) Hydrogen production from residual biomass from banana production is one of the main bananas exporting countries worldwide, making it a great source of residual biomass generation. The objective of the project is to explore supercritical water gasification technology. We want to obtain hydrogen from banana waste and develop catalysts to optimize hydrogen production (Torres, 2018). Figure 5 shows the percentages of the planted area in the Province of Manabí.

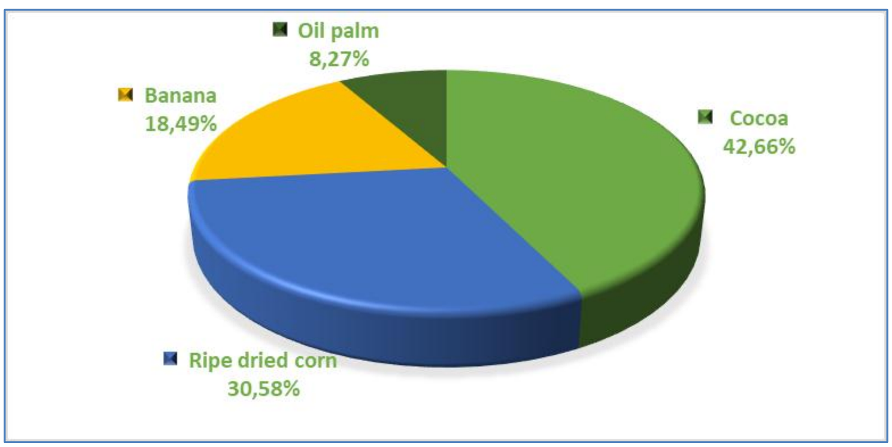

Figura 5. Superficie plantada en hectáreas de principales cultivos en Manabí

In Figure 6, it can be seen that cocoa has the largest planted area with 114,553 hectares, however, it has a considerably low production level concerning its predecessors (57,753 tons). Dry hard corn with a planted area of 82,123 hectares with a production of 457,421 tons, making it the product with the highest amount of production. The plantain has a planted area of 49,658 hectares with a production of 235,049 tons lower than the hard corn, and finally the oil palm has a surface of 22,209 hectares with a production of 273,988 tons.

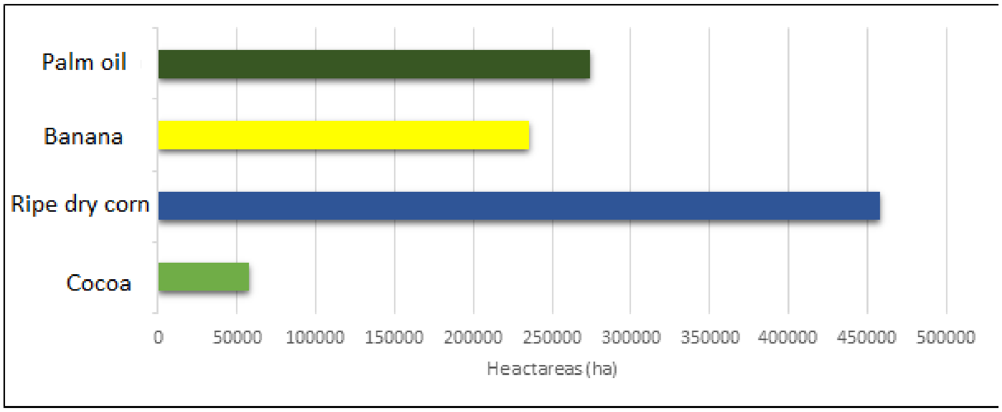

Figure 6. Production in tons of main crops in Manabí

Cocoa

The cocoa shell has a moisture content of 85.1%, volatile material of 66.8%, an ash content of 8.9%, fixed carbon of 24.3%, and elemental carbon content of 45.3%, hydrogen of 5.5%, and oxygen of 39.4%. The superior caloric power (PCS) on a dry basis was 18.2 MJ / kg. Then, the effect of temperature and residence time on the properties of the solid biofuel was studied. As a result of this study, it was obtained that the temperature has a statistically significant effect on the content of volatile material, fixed carbon, ash, and hydrophobic nature; while residence time, temperature and the interaction between these two variables had a statistically significant effect on PCS, mass and energy performance (Cayo Reinoso, 2018; Maydasari, 2016; Spencer *et al.*, 2000; O'connell *et al.*, 1998; Mao *et al.*, 2000).

Dried hard corn

Corn-based bioethanol, for the production of bioethanol based on corn there are two main processes: dry milling and wet milling. Wet milling is a process where the corn grain must be separated into its components, with the advantage that by-products of higher added value are obtained. In wet milling only the starch is fermented, while in dry milling the whole mash is fermented. There are two main by-products of the process: carbon dioxide (CO_2) and distilled grains (DDGS). Carbon dioxide is cleaned, compressed, and sold to be used as a gasifier in beverages or to freeze the meat.

Corn-based biodiesel

There are more than 350 species of oilseed plants as sources of base vegetable oil for biodiesel, among which are corn, with yields of 145 kg of oil/ha. Other sources of biodiesel are oil used for cooking and animal fats (Arvizu Fernández, 2011).

Bioethanol based on the banana peel

The banana peel is mainly composed of cellulose, hemicellulose, and lignin, its composition varies depending on the origin of the material, it is also an abundant source of cellulosic material, it is the external constituent of banana and represents around 40% by weight (Godina Villarreal & Salvador Hervert, 2012).

Oil palm

Oil palm is a commodity that has the property of being a 'flexible crop', that is, it can be used to make different products and aimed at different markets: human and animal food industry, non-food industry, and more recently, strongly, biofuels. In Ecuador, the proposal to make biodiesel from palm oil did not materialize, due to its high production cost, which, unlike its neighbors Colombia and Peru, did not allow the sector to expand thanks to the national market. The strategy before this is to expand the international market: sign trade agreements and seek new market niches. In this way, the State has contributed to this strategy to unfold (Lasso, 2018).

Manabi and the climate situation

It is reflected in the behavior of water resources, rivers gravitate to the regularities and irregularities to which the El Niño phenomenon submits the resources of the province, in this case referring to Manabí (Rodríguez *et al.*, 2019), also, most of the rivers are no permanent rivers but are only winter rivers. Therefore, it is argued that the natural resources of Manabí (land, soil, water) are not permanently enhanced by a climatic regularity that can determine production processes (Mendoza *et al.*, 2019).

As there are high temperatures produced by global warming caused by climate change, droughts occur that affect agricultural production, leading to a shortage of the fruit, since it is directly altering the natural cycle of the plant and therefore the decrease in matter prima, which is essential for this renewable energy (Rojo, 2019). To these droughts we must also add sporadic flood cycles that also affect the rise and productive growth of agricultural activity.

Regarding the origin of the biomass previously chosen to investigate, understood cocoa or coconut residues, the climatic factor does not stop taking the main role in obtaining these. When the temperature between day and night varies by more than 9 degrees Celsius, it affects development and production. Temperatures greater than 38 degrees Celsius and less than 15 degrees Celsius, affect the operation of the plant and its productivity (Ávila, 2013).

The areas where rains fall between 1,500 to 2,500 millimeters per year are the best for the cultivation of cocoa. The rain must have a good distribution during all the months, because prolonged dry periods, of more than two months, affect the production and the trees wilt (Ávila, 2013). The coconut tree requires warm weather, without great temperature variations. The average daily temperature around 27 degrees Celsius with variations of 5 to 7 degrees Celsius (Ministry of Agriculture and Livestock.).

Due to the geographical distribution of the coconut tree, it can be concluded that warm and humid climates are the most favorable for its cultivation. Low or excessive atmospheric humidity is detrimental to the coconut tree (Rastogi & Raghavarao, 1994; Jústiz-Smith *et al.*, 2008; Nair & Balakrishnan, 1977). Less than 60% relative humidity is harmful to the plant. When the water table is shallow (1 to 3 m) or when irrigation is guaranteed, foliar transpiration increases, caused by low atmospheric humidity, inducing an increase in the absorption of water and nutrients by the roots (Ministry of Agriculture and Cattle raising).

This is how it is discerned that, in the event of sudden variations in temperature occurring during the growth process of these fruits, this will be slowed down or will directly fail; if this were to occur, obtaining the bagasse useful for the generation of gases would reduce almost completely, since other alternatives not contemplated in the current approach would be taken (understand other alternatives such as residues other than coconut and cocoa).

At the Technical University of Manabí, work is being carried out on the implementation of a Geographic Information system for sustainable development (http://geoportal.utm.edu.ec), which will allow an inventory of the renewable resources available in the province where the biomass of different types of agricultural productions (Martínez *et al.*, 2019); It will also allow exchanging information, transferring knowledge, and promoting the implementation of projects related to sustainable development and especially in reducing environmental impacts (Rodríguez *et al.*, 2019).

4 Conclusion

The province of Manabí has a wide territorial availability for obtaining biomass, the same that goes unnoticed without knowing that it is a good material for the creation of renewable energy sources and thus be able to contribute a small amount of support towards the promotion of totally clean energy with zero dependence on fossil fuels, while creating better living conditions for the general population with the contribution of jobs and an ecosystem with higher quality of life benefits.

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Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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