



## Assembly of Matted Panels with Guadua Cane (*Angustifolia Kunth*), for Construction of Houses in Manabi Province



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### Article history:

Received: 27 August 2016

Accepted: 30 January 2017

Published: 31 March 2017

### Keywords:

*bamboo cane;*  
*energy economy;*  
*social impact;*  
*technological process;*  
*woodhouses;*

### Abstract

In some regions of Ecuador, mainly in the rural areas, the bamboo cane (*Angustifolia Kunth*), is presented as a renewable natural resource par excellence, which has ecological importance, the wood obtained from this plant is used since very ancient times in the construction of Housing, its technology has not changed in several years. Its industrialization is restricted, due to different factors, mainly because the natural characteristics of the material are unknown, such as age, moisture content, soil nutrients, and treatment after cutting, among others. Knowing these elements can be implemented technologies for the cutting and sterilization of the wood obtained from these plantations and develops a national technology for the construction of housing for social use, thereby achieving an impact on society by having more comfortable, safe and economic facilities. The objective of the research is to propose machine tools that allow creating panels for the construction of houses with higher quality, improving with it the living conditions of many populations in Ecuador, mainly in the province of Manabí, being a territory that does not have machines suitable for the processing of bamboo cane.

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## 1. Introduction

The man has realized different types of constructions depending on the geography of the place, the existing materials and the tools, being these of smaller or greater of complexity like: temples, palaces, houses, among others, that were implemented taking into consideration the availabilities And goodness of the place, managing to combine the natural resources existing in the territory with the skills, skills, techniques, functions, trades and ancestral knowledge that gave shape to the different constructions designed and proposed from the time in which they lived.

The bamboo cane *Angustifolia* Kunth belongs to the bamboo family, these grasses are recognized for their high use in different parts of the world as bamboo or bamboo, which come from South East Asia, have spread throughout Latin America. It is considered that there are 1500 species of herbaceous and woody bamboos around the planet, in Ecuador, we have about 280 species of bamboos.

From ancestral times in the province of Manabí homes were built using materials obtained from the *Guadua* cane, many of these were worked by people who needed it without previous treatment in their court and matting. These processes were carried out without much technology, thus causing the work to be rude and in many cases affecting the health of the people who exercised it; But also its quality was not adequate.

In the country, in the coastal region or coast the people that live in the settlements bordering it especially are estimated as poor 74.8% ([Asamblea Nacional, 2015](#)), with a housing deficit of about 180,000 homes; this shows that plans, local and national housing programs do not meet the demand for housing reported to meet the needs of the population considered as poor.

In Ecuador, 60.1% of the total population of the country is considered with poverty levels, the provinces of the coast; (61.2%), Esmeraldas (78.3%), Guayas (58.4%), Los Ríos (79.5%), Manabí (76.8%), which are well above National average ([Karina Monteros Cueva, 2015](#)). There is a high housing deficit of about 180,000 homes; this shows that plans, local and national housing programs do not reach out to the most vulnerable population in this region of the country, which leads to reconsideration, new planning and new housing projects that allow housing access to the large masses of the population considered poor.

In the province of Manabí, the houses and their construction were linked to materials of the general environment with the use of a bamboo cane as a construction material, combined with other materials such as clay (straw + straw + livestock manure). The text endorsed on September 28, 2008, replacing the previous Constitution of 1998, addresses in an innovative way the right to housing. The Constitution of Ecuador represented a great advance for the realization of the right to housing and a dignified city in the region ([Constituyente, 2008](#)).

In this area, the dwelling and its construction were always linked with materials of the environment, to express this fusion with the same, nothing better than the application of the bamboo cane as a construction material, combined with other materials such as clay (straw + Livestock manure).

The mixed materials were used to smear the walls, lying down, which gave the house a cozy appearance, served to protect the winds, and inclement the climate, also used the bahareque technique where the *guadua* cane is mixed with the enquinche Giving more consistency to the walls and ceilings. Another technique is the mixing of the bamboo cane in the form of a mat or chopped cane that is the same cane chopped manually and transformed into a board that is then combined with the wood where the carpentry technique is applied to make floors, doors, windows, balconies, stairs among other elements that required housing at the time ([Morueta, 2013](#)).

In this context, the objective of the present study is to assess the impact of the matte panels that were used and transformed into houses of cane *guadua* for people with limited economic resources; For this social group it is much more difficult to have a dignified home that allows being a habitable place, with certain hygienic amenities that protect against cold, heat, rain, humidity and threats to health. Houses designed with other materials have high costs such as iron, cement, bricks and other materials that make building social housing more expensive, houses built in cane *guadua* are fresher, safer because of their earthquake resistant properties and more economic too, available to a large majority of poor families in Manabí. This entails generating new popular programs for the production and acquisition of priority social interest housing, working with the participation in agreements of public sector entities as well as private institutions ([Muñoz, 2015](#)).

## 2. Materials and Methods

For the use and the elaboration of matted panels of cane *guadua* a program was prepared that manages the care of the plantations so that the activities realized in the process of the cut until the construction of the panels do not

produce affections to the environment in the zones where Are plantations, so that the environment is protected and there is no deforestation affecting the territory and land use. A plan for forest utilization was developed taking into account the area, volume and the possible duration of the use, as well as the current state of the gradual; In addition to using silvicultural practices for the sustainable management of the forest.

### 3. Results and Discussions

Currently, in order for the low-income population in the province of Manabí to have access to low-cost housing, it must contact the production matrix located 300 km away in the province of Guaya. This requires effort and money, in The current technological proposal proposes a model that can be observed in figure 1, where the needy population become part of the marketing process because they can actively participate in the first stage of work that is the crop of the plant (here Includes the whole process of planting, pruning, cutting, curing, drying); Later they can intervene in the technological process, the construction of the panel and its commercialization, being part of the users, saving money and with the possibility of acquiring a house with better quality in its construction next to its place of residence, provoking that the social impact Is high, opening new jobs and improving the quality of life.

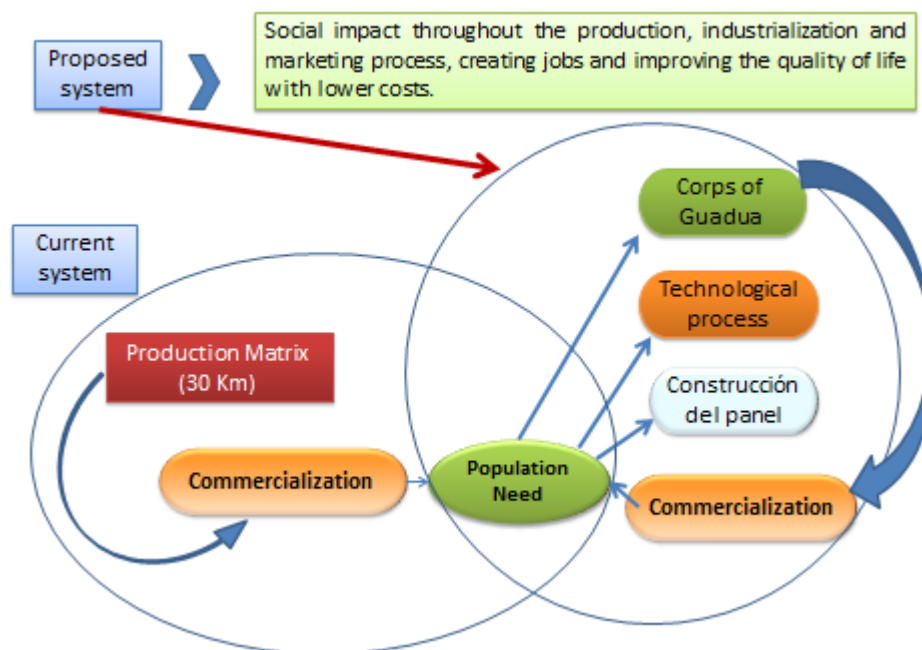


Figure 1. Model of the commercialization of guadua cane

This proposed model will allow the province to carry out all industrial activities and processes for technical production, with energy efficiency and economic optimization in the manufacture of matted panels. The technology is based on the transformation of round canes into very strong flat surfaces, without waste, without complex equipment, that will be used in a systematic way in the assembly of popular housing of social interest, that will provide the elements that assure its habitability, with standards of quality in urbanites, architectural and construction design for the benefit and comfort of those who use it as permanent housing (Navas, 2011).

This study of the design of a prototype of a guadua caning machine will allow creating a series of benefits to the different surrounding communities where this project is carried out since the resource as a raw material will have a greater consumption demand for the improvement Cuts and increased production. The machine of this study has a horizontal operating characteristic to transform the raw material (cylinders of 12-14 cm in diameter, 2.40 m in length of bamboo cane), which will be processed through the use of a mechanical power system, which Will be powered by a 7.5 hp motor, transmission of force and speed with pulleys, belts, cogwheels and chains, will be used to optimize

work, improve performance, organize the manufacture of different bamboo cane Measures in relation to width, developing strengths and consciences in the inhabitants of certain regions of Manabí, who would use their skills and abilities to meet the needs, be able to mitigate the environmental impact of the homogenous safe management without deforesting of the gradual, that will be priority for the Continuity and the development of the company dedicated to this work, giving a higher quality of manufacture to the product and thus improve the change of the productive matrix in the region.

Any productive process that allows the extraction, transformation, transport, application, and use of raw materials as building materials demand energy consumption and therefore higher CO<sub>2</sub> emissions into the atmosphere. Each m<sup>2</sup> of the conventional building represents 7 tons of CO<sub>2</sub> emitted into the atmosphere, contributing in a sustained way to the greenhouse effect, whose cause generates the global warming and this, in turn, causes the climatic changes that produce the natural disasters and impacts in many regions of the planet.

Guadua plantations are alternatives to reduce the greenhouse effect, each hectare of sugarcane consumes 12 tons of CO<sub>2</sub> from the environment, with these crops the natural environment is strengthened; In addition to generating the raw material for the construction of the low-cost housing from the elaboration of the matted panels. In figure 2, the energy consumption of some materials used in the construction of houses can be observed.

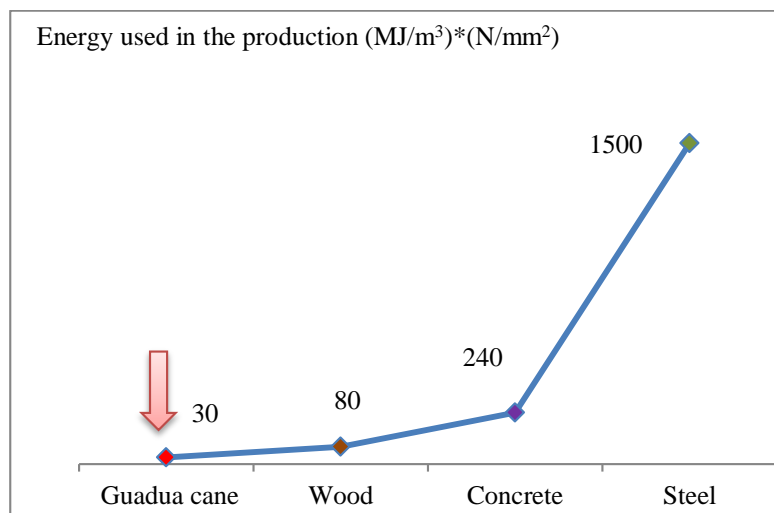


Figure 2. Energy used per m<sup>3</sup> of material

It can be seen that Guadua cane is the material with less energy expenditure, which can be thought to be competitive with other materials that can be available to users, proving that the guadua cane has properties and benefits Energy-Economic Which can be used for the construction of popular housing of social interest in the province of Manabí; But there are other qualities of guadua cane such as: Accessible and economical, environmentally friendly and renewable materials, less weight, conductivity and thermal inertia (depending on the climate), high resistance to physical and mechanical stresses, reasonable resistance to humidity, Sound insulation, durable, very good ability to adapt to other materials, reduced energy incorporated, aesthetic appearance positive and recyclable at the end of its useful life.

With the qualities listed, it becomes an alternative material to achieve sustainable development of the region being self-sufficient for existing plantations and their characteristics. It presents benefits to the soil such as water basin conservation, oxygen generator, water retention, slope stabilizer, natural riverbank protector, the habitat of flora and fauna varieties, natural climatization. With its large volume of foliage actively participates in the oxygenation of the environment and its rapid growth integrates faster than other species in the hydrological cycle (SENPLADES, 2011).

In the territory its uses are varied, they can serve as agricultural implements, sheds and light roofs, bleachers for mounting roundabouts and festivities, fences of pastures and grounds, areas for grain storage, urban and rural houses with structure of round cane applied in Floors, walls, ceilings, and other applications such as the manufacture of baskets, utensils, handicrafts, musical instruments, living room furniture, dining rooms, bedrooms, wall lamps, coffee tables, lamps, among others.

Coastal regions are exposed and vulnerable to natural disasters such as landslides, floods, droughts, high temperatures resulting from global climate change that become more frequent. Natural phenomena are becoming more severe and their socio-economic impacts directly affect the sites or places where they occur; there are mainly populations living in high-risk areas that also have low productivity indices of several elements that affect the livelihoods of the families in those regions that are determined by market variations in the price of their harvested products (Solórzano, 2010).

The improvement of the technology of the construction of panels for the manufacture of houses can have a positive social impact in the improvement of the living conditions of the poor population of the coast of Manabí, being a light material, easy to work, to transport, with Qualities for the construction, that can be worked with elementary tools; By the configuration of the fibrous and hollow trunk, is easily cut to be reduced to rods, ellipses or mats and to exist in large quantities in the region serve as a possible alternative for the development and construction of housing for the poor population. Figure 3 shows how the mat is produced with basic tools such as axes, machetes, and ripper.

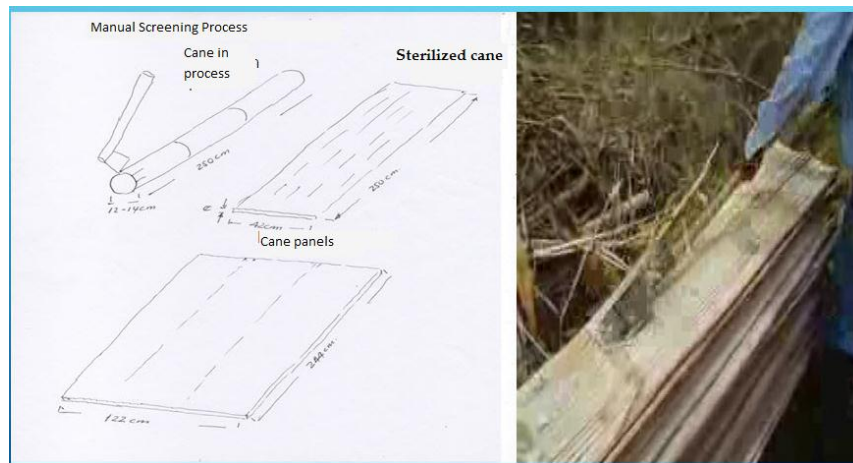


Figure 3. Current process of manual or artisan weeding of the guadua reed

There are still these rustic methods in the province, to introduce new forms for the mat-chopping and cleaning the bamboo cane, would have better housing, construction will be faster and poverty rates of the area in the area of social interest Proposing construction of low-cost houses with panels made of guadua next to the consumers with lower prices that makes the mass consumption of the population.

#### *Improving cutting and chip technology*

When introducing new forms of cutting and grinding, the work is humanized and better quality is obtained in the process in figure 4, a prototype of a machine is shown, as shown, is equipped to be done automatically where it is not Use the tools seen in Figure 4.



Figure 4. Proposed technology for the cutting and chipping of guadua cane

The reeds that the machine will process, will be of a length of approximately 3 meters, to achieve a greater efficiency it is desired that the cutting time is less than 30 seconds. The technical analysis of the design, are based on International Standards of Bamboo production and applied in Asian regions, such as China, Korea, Taiwan, and Japan.

The impacts associated with the new housing construction technologies with industrialized guadua cane panels create jobs from planting until it is assembled, improving the living conditions of the population of the Manabí coast and being trained to learn all technologies Associated from the management of the guaduals to the elaboration of the panels.

#### 4. Conclusion

The cane guadua generates socio-economic impact in the inhabitants of the different sectors where there are guaduales when implementing the labor in sowing, maintenance, cutting, curing, handling, and transport. The construction of housing of social interest imposes a tendency in the design and technological construction for the process and production of matted panels that will improve the quality of life of the inhabitants of the coastal área.

##### *Conflict of interest statement and funding sources*

The author(s) declared that (s)he/they have no competing interest. The study was financed by the authors.

##### *Statement of authorship*

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

##### *Acknowledgments*

Special thanks are given to the administration of the UTM, for allowing this research to be carried out, in addition to the students who have been involved in its realization.

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