Jorge A. Morán Ubidia*: **The Use of Bamboo in Ecuador: Past, Present and Future****

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1. Introduction

When discussing the use of bamboo in Ecuador it is necessary as well to discuss her culture and even her history. Bamboo has served, and still serves hundreds of thousands of Ecuadorians as construction material for their dwellings and objects in daily use. It is also found in clusters adjoining the rivers and estuaries of the Ecuadorian coast, acting as an extraordinary agent against erosion and an outstanding contributor toward ecological maintenance.

In this paper I will explore the works of outstanding archaeologists who have shown that all cultures that have lived on the Ecuadorian coast used "caña," or bamboo†, and "guadua," or giant bamboo, as construction material for temples and dwellings. I will examine the first written and graphic accounts that chroniclers of the period of discovery and colonialization left about the use of this plant, with special emphasis on the commentaries about guadua left by Humboldt in his passage through Ecuador.

Humboldt notes how peasants and migrants living around the edges of cities used guadua to create large neighborhoods of bamboo, highlighting the case of Guayaquil. The history of Guayaquil has been bound to the use of bamboo from the days of its founding until present times, where living in a house of bamboo has become synonymous with uncertainty, misery and poverty. I will conclude the document by noting the temporary residence in Ecuador of Floyd A. McClure, reviewing the first successful housing projects in the country, and highlighting the investigations of the University Laica Vicente Rocafuerte of Guayaquil into ways of salvaging and constructively using one of Ecuador's most important resources, its bamboo.

2. Archaeological Evidence

> "...Scientific investigations have earned the Ecuadorian coast recognition as the source of New World ceramics; together with Puerto Hormiga in Colombia it includes the oldest known centers..."[1]

This is how Olaf Holm[1] begins his study of the prehistoric dwellings of the Ecuadorian coast. He gathered the observations of well-known investigators on the materials, forms, and construction techniques used in Ecuador's first dwellings.

Climate and natural resources have determined the type of construction material available to Ecuadorians, thus giving form to the dwellings and the construction system best suited for building. While the Peruvian coast, dry and desert-like, requires bricks and

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** Translated from Spanish by René Lewis. Edited by W.A. Brewer.

† In this document the words "caña" and "bamboo" will be used somewhat interchangeably, though "caña" often refers specifically to the bamboo cane and "bamboo" to the plant as a whole. Translator's note.

adobe, that of Ecuador is warm, humid, and full of the plant resources required for the construction of temples and houses. Reason dictates that the trunks of trees and guadua are suitable materials for the supports, that palm and bijao leaves are destined for roofs, and that the same guadua cane, opened and flattened, is the best material for floors and walls.

I will examine some ruins and how they were interpreted by archaeological investigations. Dr. Karen Stothert, together with the Anthropological Museum of the Central Bank of Ecuador, discovered the oldest dwelling of the preceramic period in the Peninsula of Santa Elena[2], where the vestiges of foundation trenches show where posts of wood or caña once were buried to form the framework and support the roof. Radiocarbon readings date the few other cultural remains at between 8900 and 9400 B.C., making this dwelling the oldest in Ecuador and all of America.

Figure 1. Circular plan of a cabin in Las Vegas, on the Peninsula of Santa Elena. Only the trench and the places where the structural posts were once buried remain (9000 years B.C.).

From the later Formative Period (3550 to 500 B.C.) are the remains of the dwelling of Valdivia I in Real Alto, where one can make out the remains of the posts in the oval floor plan. In 1979 J.E. Damp[3], using the radiocarbon method, dated the remains at 3500 B.C. D.W. Lathrap and J. Marcos of the University of Illinois[4] concluded that the dwelling in Real Alto had its walls plastered with *bahareque*, or caña, mud and straw. This construction technique is still used today.

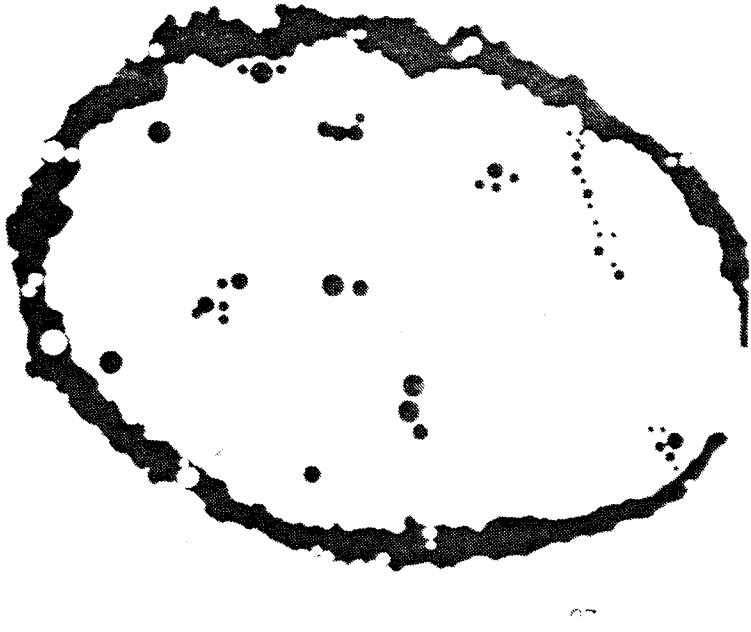

Figure 2. Excavation in the Real Alto site with vestiges of interior divisions. It can be seen where the bamboo posts were located (3500 B.C.).

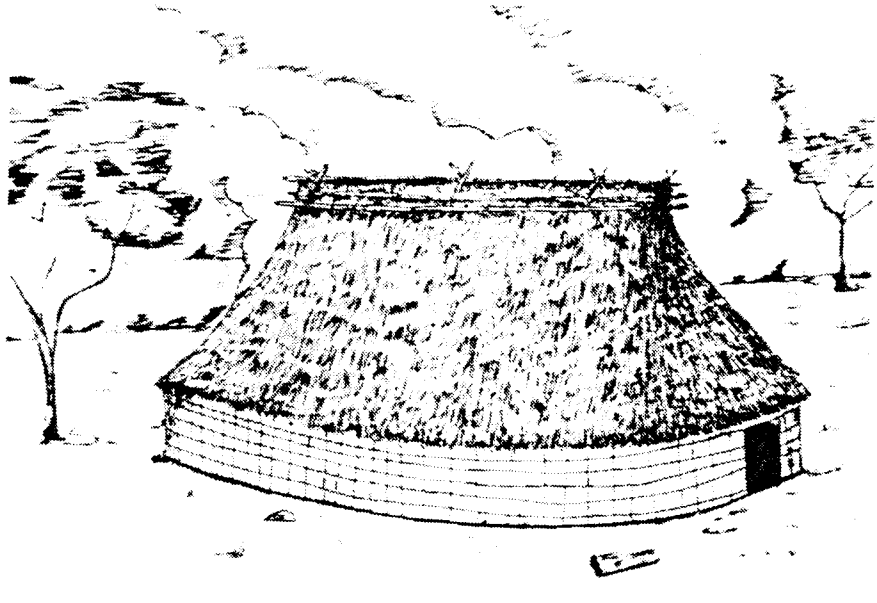

Figure 3. Reconstruction of the dwelling of Real Alto.

Clay maquette-vessels from the Chorrera culture (Bank of the Pacific Museum, Guayaquil) reflect the forms and techniques of construction of the times, and show the same materials in use as those suggested by the cylindrical vessel of the Jama Coaque culture (Central Museum of Ecuador) that represents a cellar or grain storage area with walls of guadua. The decorative elements are made by using fixed or mobile "stamps," the latter in cylindrical form, made by fastening together sections of guadua, as shown by the archaeologist M. Molina[5].

In 1907 M.H. Saville[6] described the ancient town of Manta, then called Jocay. From examining its remains, called "corrals," he concluded that the foundations were of uncut rock and the walls of adobe, caña, or both, permanently joined by the *quincha* system of construction still predominant in the Province of Manabi. In 1962 V.E. Estrada[7] also described the ancient Manta, and together with Clifford Evans and Betty Meggers[8] of the Smithsonian Institute made several archaeological investigations. After analyzing a multitude of maquette-vessels from different periods they concluded that

> "...the buildings had stone floors in some cases, and walls possibly of *bahareque*, and roofs of straw..."

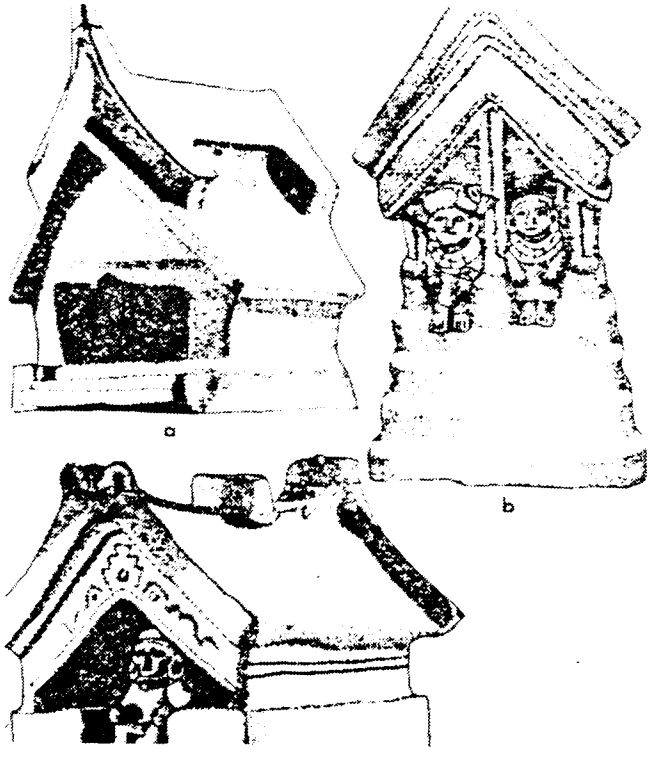

Figure 4. Maquette-vessels from the Jama-Coaque culture (500 B.C. to 500 A.D.).

Each archaeological investigation points to guadua as the basic pre-Columbian material for construction, as indicated by the work of Dr. Merino:

> "...in the archaeological site Milagro I, (5500 B.C. to 3800 B.C.), they have found numerous fragments of bahareque, a clay covering, on top of the walls

> of caña. We can safely conclude that the inhabitants of Milagro I constructed their houses with walls of caña and surfaced them with clay or bahareque..."[9]

The purpose of Gustavo Borja's[10] study of pre-Columbian maquettes is also to better understand the structural behavior of guadua in construction.

The Chirije site[11] explored by Estrada shows the remains of perforated columns - unique molds of the primitive guadua structures - that would later draw the attention of the first chroniclers who, with the discovery of America, would arrive in Ecuador.

Figure 5. Excavation that shows the perforated columns of corral A of the Chirije site.

It is necessary to note that guadua was also brought from time immemorial to Peru. The Harth-Terre chronicle notes the ruins of the city of Chan-Chan, as described by Francisco Iriarte:

> "...the adobe was made in *gaveras* (molds). In Huaca Blanca, adobes have been found made in gaveras of guadua..." (p. 6)
>
> "...as increasing numbers of the tall walls surrounding each of the complexes are disassembled, stuck in each of their centers, lengthwise and at regular intervals, there appear large cañas of a diameter varying from 4 to 6 cm at the tip..."[12]

That is to say, not only the Ecuadorian cultures used guadua, but those of Peru also used it during the pre-Columbian period, as demonstrated by the ruins of Chan-Chan, and during the colonial period, as demonstrated by the Palace of Perichole and many buildings still present in Lima. This made Christopher Alexander recommend

> "...bring caña from Ecuador at convenient prices to implement housing plans in Peru..."[13]

3. First Graphic and Written Accounts

Since the Spanish conquistadors first visited the coasts of Ecuador, chroniclers and reporters of the period have left numerous documents mentioning the existence and use of "caña" or "guadua." I will present some testimonies which, taken in chronological order, give the reader a panorama of the traditional way to use bamboo, and the technology that has maintained itself through the passage of the centuries until present times.

1526 Juan de Samano, Secretary to Emperor Charles V, transmitted to the royal family of Austria the description given by the chronicler Francisco de Jerez about the exploration voyage of that greatest of pilots, Bartolome Ruiz, carried out for the first time on the Ecuadorian coast. In part of his account, while referring to a *balsa* - a type of indigenous boat made of caña, which approached his vessel, Ruiz wrote "...it was made with a keel of cañas as thick as posts..."[14] This is the oldest reference to Ecuadorian caña.

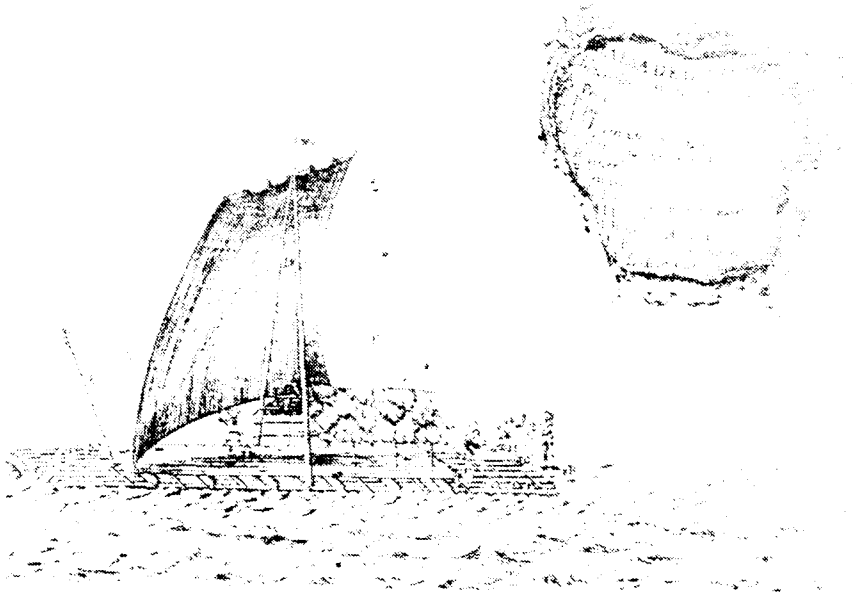

Figure 6. Balsa of Guayaquil. Picture by Jorge Juan y Antonio de Ulloa, 1740.

1534 The historian Herrera in his *General History of the Works of the Spaniards*, refers to the expedition of the Captain General of Guatemala, Pedro de Alvarado, from Bahia de Caraquez to Quito in 1534, recalling how guadua saved the lives of the explorers:

> "...thirst cruelly tormented them in the suffocating climate of the mountains and their distress grew with the lack of water... They found a spread-out canebrake of guaduas; they thought that there would be water, but they did not find any. It had been more than two days since they had found a way to quench their thirst,... A black man began to cut cane to form an arbor and with great surprise saw that the *cañutos*, (the culm internodes), contained more than an azumbre (four pints) of pure,

fresh water; within the cut canes they found a sufficient quantity of water for the horses and themselves..."[15]

1559 From the pre-Columbian period until now the coasts of Ecuador have provided wood and caña for Peru, according to the account "The Relation of the Canon" of the Cathedral of Kings (la Catedrál de los Reyes) in Lima, cited by Dr. Julio Pimental Carbo, an illustrious Ecuadorian historian. The account states that up to a distance of many leagues from Lima there existed no wood of any sort, and that because of the need to build houses "...they brought wood and caña from the city of Guayaquil..."[16]

Figure 7. Picture of a *balsa*, by Girolamo Benzoni, 1565.

1565 One of the first pictures of the Ecuadorian *balsas* was left us by Girolamo Benzoni. He also left one of the first descriptions of the use of bamboo in work with precious metal. When referring to the process of casting gold and silver that uses bamboo to fan the fire: "...with 5 or 6 *cañutos* of caña, now more, now less, they blow so much that the metal melts and can be poured..."[17] In the province of Manabi, Ecuador people still use sections of bamboo from 25 to 30 cm long, called *sotos*, that when perforated serve for blowing and aerating kitchen fires.

1605 The public service buildings also were built with caña, as shown by the petition for income in July, 1605, for the Santa Catalina Hospital in Guayaquil. The witnesses testified as follows:

> "...the walls of most of this hospital are of bahareque and caña..." (From Don Andrés Morán de Buitron, Notary of the *Santo Officio* of the Inquisition)
>
> "...the major part of the fences of this hospital, and its walls, are of bahareque and caña..." (From Don Alonso de Vargas, Sergeant Major and Mayor of his city)[18]

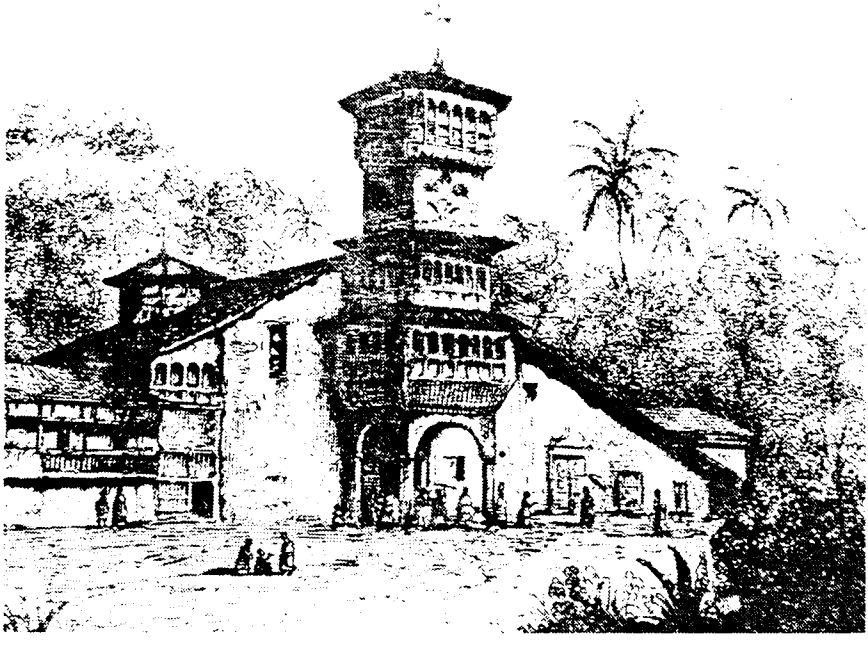

Figure 8. Santo Domingo Church in Guayaquil. Picture by La Vigny, XIX century.

1630 Fray Buenaventura Salinas y Córdova, in his *Memorial of the Stories of the New World*, (Peru, 1630; Lima, 1957), writes

> "...that from twenty to thirty ships, loaded with wood and caña, left each year from Guayaquil to Callao..."[19]

1630 In "Idolatries of the Checras and Andajes," documents from the Archive of the Archbishop of Lima, the inspector and chronicler Pedro de Celis relates the strange case of a caña that was the object of adoration

> "...there was a big caña from Guayaquil to which they offered food, coca leaf, corn liquor, and other things..."

Add the testimony of an Indian from Palpas:

> "...they obviously respected this caña a lot because they brought it to Csasa Paico from time to time..."[20] Csasa Paico was a *malqui*, or idolized mummy.

There is no evidence that caña grew near Palpas, which would explain the reference in the cited document to "...the caña of Guallaquil...," a city situated 1000 km from Palpas.[21]

Figure 9. A Chinchaysuyo Burial. Picture by Poma de Ayala. (See note 20)

1740 The description of the voyage from Lima to Caracas (1740-1741) by Don Miguel de Santisteban gives us numerous references to the use of caña or guadua in Guayaquil:

> "...houses with shelves of wood, covered with straw and strips of those cañas they call guaduas, and so thick that, split and flattened, they give a board two-thirds of a vara wide (a vara = .84 meters), and a very strong texture..."
>
> "...they make the floor of the wanted thickness, weaving with flattened guaduas...placing them whole, straight up, as panels to divide bedrooms..." pg. 92
>
> "...Saturday the 6th of August, 1740, we left this first beach...I examined the basis for the common opinion of this province that the water contained in the caña that they call guadua rises and falls with the phases of the moon...I found that in some, the water had risen to almost the caña's full height, up to 50 feet tall and 24 inches wide, and that in all, one would find water more fresh than is common and natural..." pg. 99[22]

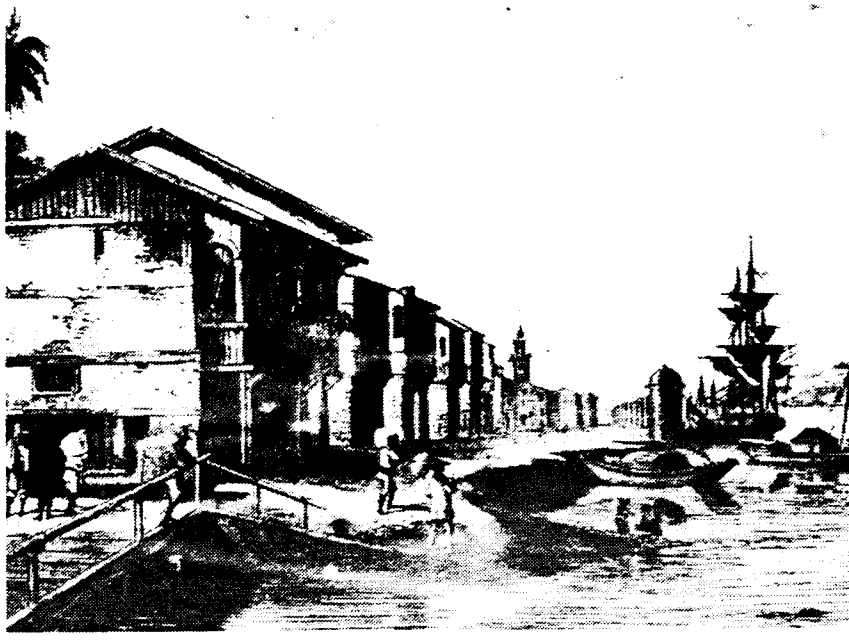

Figure 10. Engraving of Guayaquil, according to Charlton, XIX century. (Collection of Castro and Velazquez)

1741 The president of the Royal Audience of Quito, Dionisio Alcedo y Herrera, wrote a valuable document about the province, river, and port of Guayaquil containing numerous details of the period and describing the inhabitants' customs, and the flora and fauna of today's Ecuadorian Provinces of Manabi, Guayas, and Los Rios. I will cite some of his numerous remarks about the uses of caña.

In describing the *balsas*' *guare*, or rudder, he says:

> "...they manage it very easily, with a caña like the ancient *pinzote*..." (Chap. VI, p.32)

He notes the existence and size of the cañas:

> "...they find wild caña of such size, up to fifty feet tall and sixteen inches wide, that they are used for the frame and protection (floors and walls) of the sides of country and city houses alike..." (Chap. VIII, p.33)

In the same chapter, now referring to the water contained in the *cañutos*, he says

> "...they are natural water pipes (tubes or pipelines) that contain at the waxing of the moon a light, crystalline, and deliciously cold and healthy deposit of water..."(pg. 34)

He also describes the houses:

> "...they form spaces out of walls and roofs with bent, wild caña, opened and leaning towards the interior, that they trim and cover with awnings in such an orderly way as to close the openings, thus forming houses..." (Chap.X, p.37)[23]

1748 Jorge Juan and Antonia Ulloa were sent by King Phillip of Spain, together with French academicians, to carry out various measurements and calculations in the field of astronomy. They left, among their many written works, a description of the city of Guayaquil including the forms, materials, and construction systems of the residents' houses. They incorporated in their documents one of the first pictures of the houses, the design of which has been maintained in all the regions of coastal Ecuador. It is noteworthy that in the picture, shown below, appears a guadua plantation identified by the legend at the foot of the illustration as "caña from Guayaquil."[24]

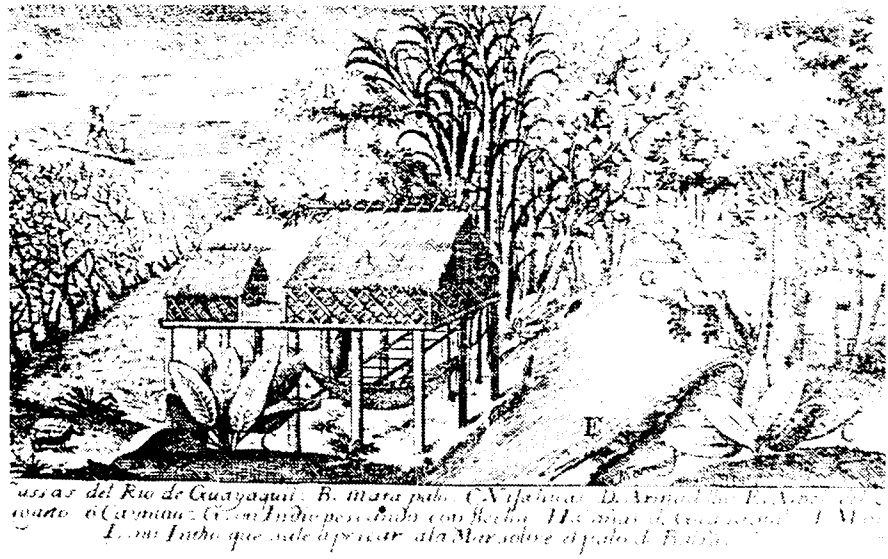

Figure 11. Drawing of house and plants of Guayaquil, by Jorge Juan y Antonio Ulloa, 1748.

1820 Andres Baleato completed a "Monograph of Guayaquil" with numerous descriptions of the use of caña as a construction material for houses:

> "...in the small houses all of the interior roof, walls, floor, stairs, handrails and so on are made of caña..." (pg. 251).

He also describes the existence of the plant:

> "...on all sides one encounters *cañas bravas*, or guadua, and bijao canes and leaves put to many uses..." (pg. 294).

He notes its dimensions, the use of the water contained in its interior, the traditional way of "curing" so it will last as long as possible, and its use as insulator in cargo boats:

> "...the cañas from Guayaquil are as unique for their length and width as they are for the water their *cañutos* contain. Their regular length is from 14 to 18 varas, the thickest are a palm in diameter; the outer circumference of the *cañuto* is 6 lines around, and one realizes that when opened

> and flattened, each one forms a board half a vara thick...during a full moon most of the *cañutos* are full of water...after cutting the cañas, they let them dry, which they call "curing." Curing leaves them strong enough to serve as beams, boards, litter poles, and sheathing for the holds of boats carrying cocoa so that the heat of this fruit will not burn the wooden hull...the water from these cañas is said to prevent welts formed by blows and falls..." pg. 305

In referring to the way of constructing *balsas*, and then in describing the method of lashing the wood with reed, he writes

> "...on these poles they form a floor of caña strips, above which they construct a hut, either a lean-to or one with a pitched roof..."[25]

This method and design is still used in today's *balsas* that transport wood and caña the length of the coastal rivers. The manner of constructing dwellings has not changed throughout the centuries, which supports earlier written descriptions of the traditional uses of caña:

1836 The historian D'Orbigny says

> "...the houses are of caña cut through the middle, without plaster or mortar to cover them, with roofs of the leaves of wild banana trees...the partition walls of all the constructions of Guayaquil are of earth (quincha) supported by cañas..."[26]

1881 Years went by and Carlos Wiener continued the description:

> "...they make the roof before constructing what is properly called a house; it serves the workers as a shelter from the sun or rain, according to the season. Beneath its cover they build the walls from boards or bamboo..."[27]

4. A Scientific Account

I want to especially emphasize the visit to Ecuador of the Baron Alexander Von Humboldt and the French botanist Aimes Bonpland, who arrived at Quito the 6th of January, 1802,[28] after beginning their scientific pilgrimage through America in Colombia. For ten months they travelled the country, making numerous, valuable observations. They travelled to Peru and returned to Guayaquil the 1st of January, 1803. There Humboldt began to write one of his most important works, "Geography of Plants,"[29] that he would publish two years later in Paris. In this work, as well as in his "Diary of the Trip,"[30] he mentions the guadua plant, giving skillfull observations about its habitat and average dimensions. He also mentions the harvesting of its fruit and calls the oily, siliceous substance (Tabasheer) that the bamboo secretes "milk of the bark," saying that they collected it for the first time to the west of the Pichincha volcano in May of 1802.[31]

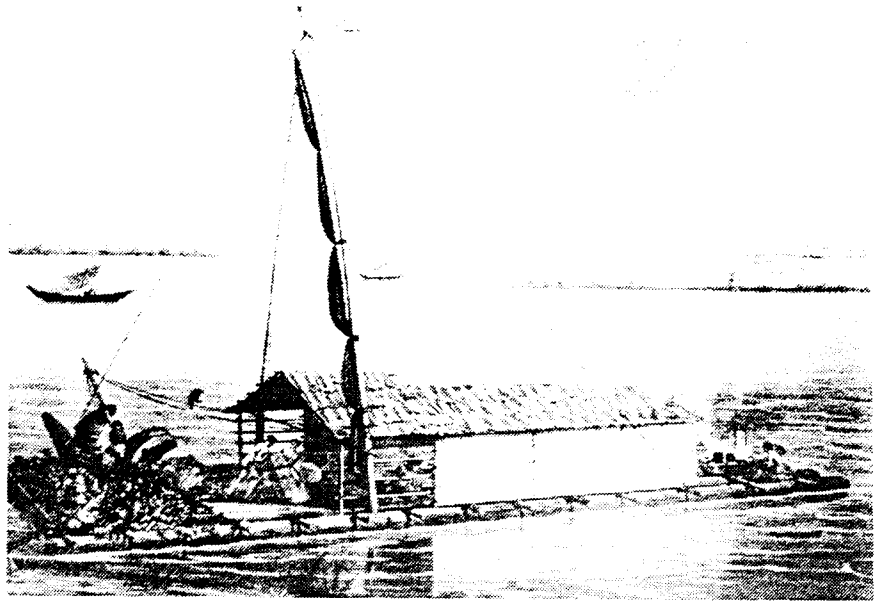

Figure 12. Traditional boat, according to a picture by Humboldt, 1803, from the L. Jijón and Caamaño Museum.

Figure 13. Bamboo flowers, picked in the experimental station of Pichilingue, in Los Rios Province.

For us, the most important and valuable contribution of Humboldt and Bonpland was to give guadua one of its first scientific names, *Guadua angustifolia*, and noting for posterity the scientific and economic importance of this grass, along with the various conditions for its optimal development.

> "...Without doubt, as social plants they offer a most luxuriant vegetation between the sea coast and an altitude of 780 m..."[32]

5. Bamboo and the Coastal Peasant

The peasants of the Ecuadorian coasts, be they montubio, cholo, moreno, colorado, or cayapa, use guadua in innumerable ways. It is not strange, therefore, to find next to their dwellings a small plantation of caña which the peasants call in their idiom a *mancha*. With the exception of the framework and the roofing material, their dwelling is entirely made of caña; walls, floors, stairs, doors, windows, and roof framework are all constructed with this material, following ancestral canons perfectly designed to meet the climatic conditions.

Figure 14. Peasant dwelling of the Ecuadorian coast, Los Rios Province.

Caña is used in various ways. They use it whole (*rolliza*), cut longitudinally in half (*guacay* or *latón*), in longitudinal sections from 6 to 8 cm wide (*latas*), in pieces 3 to 5 cm wide (*latillas*), or simply open and flattened (*caña picada*). Necessities other than houses are also made of caña; corrals, chicken pens, storage areas for grain, and objects for domestic use such as well covers, lattice frames, fishing instruments, small furniture, and poles or pruning hooks for tall fruit crops. The latter are made of bamboo poles which have been straightened by heating.

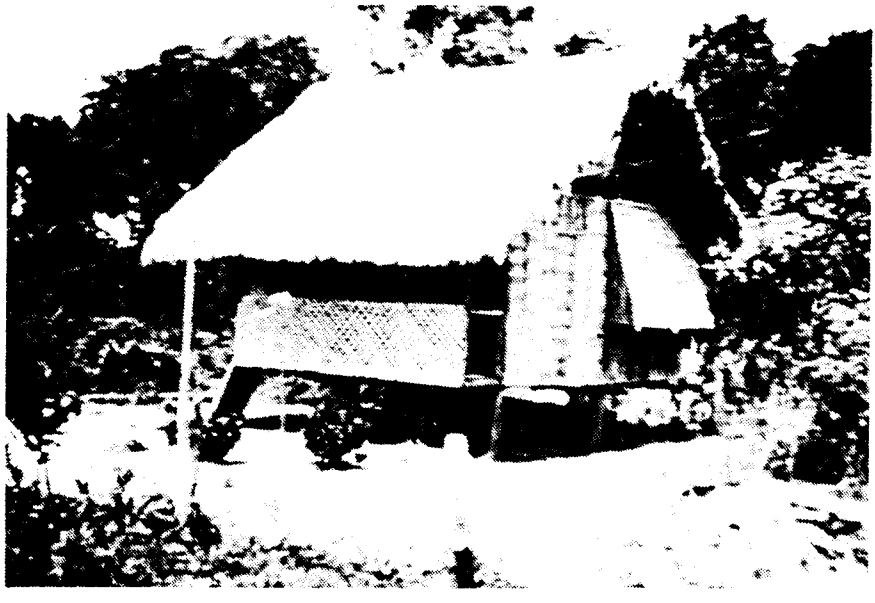

Figure 15. Peasant dwelling of the Ecuadorian coast, Guayas Province.

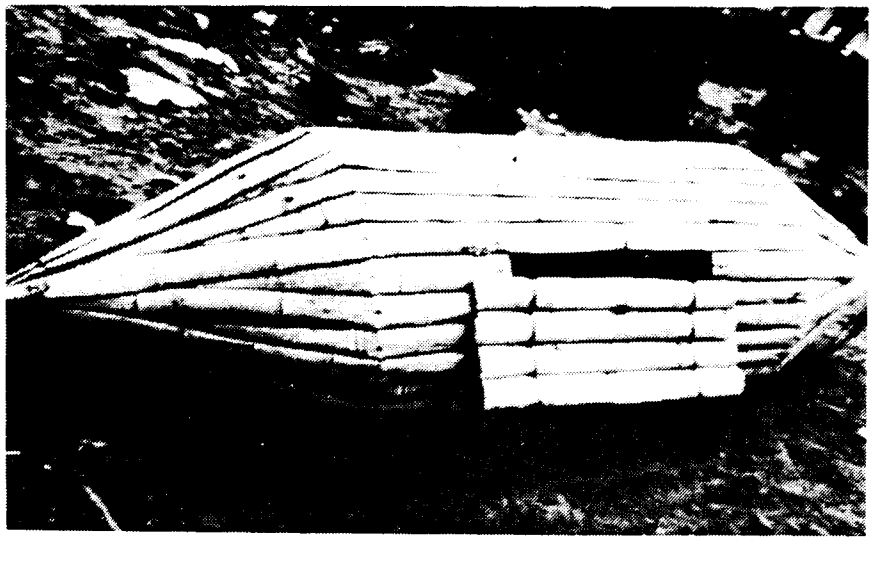

Figure 16. Fishing instrument and "cage" for live fish, Los Rios Province.

Figure 17. Pen for ducks and chickens, Manabi Province.

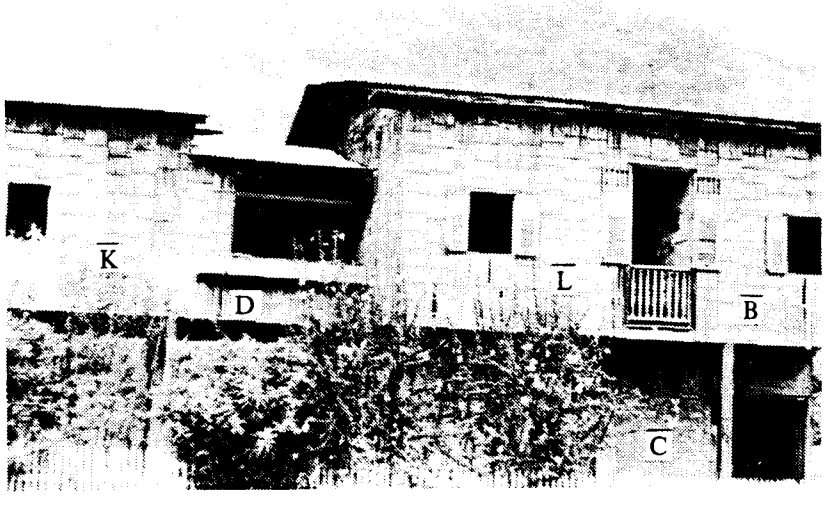

Figure 18. Peasant dwelling of "Jobo," Manabi Province. All the dwellings of this section have the same characteristics: Kitchen, Dining room, Living room and bedroom, and Cellars and grain storage areas.

Figure 19. Floating houses of the Babahoyo River, facing the city of the same name, Los Rios Province.

Today's boats preserve their traditional form, using strong, flexible bamboo as masts and rudders. The people know that one way to keep river banks from collapsing and subsequently eroding their land is to plant caña on the banks. If they need water they use an open caña to collect the rain that falls from their roof; they know that to work with bamboo they only need a machete to cut it down, open it, clean it, and transform it into the object they need. They traditionally follow the custom of cutting caña during the waning moon, at low tide, so that it will be stronger and last longer. They drink water from its *cañutos* for its medicinal effects and know how to transport along rivers enormous quantities of caña which they call *plantillas*. Bamboo helps them cultivate bananas; they support the fruit with sections of bamboo called *cujes*. Musical instruments such as flutes, marimbas, and so on are also of bamboo, as are toys such as *palos encebados* and the frames for children's kites. When "civilization" arrives they also use bamboo as poles for electrical wires and as tall bases for television antennas.

Their houses are the motif for pictures and postcards - their half-closed roofs demand a correct orientation and the perfect inclination to give them shade in hours of sun, and protection from the rain, at the same time allowing currents of air to circulate through lateral openings in the shelter, or through cracks in the floors and walls; advantage must be taken of the slightest breeze to make the hours of rest comfortable.

Bamboo, without doubt, is the most important article of the coastal Ecuadorian peasant.

6. A Special Case: Guayaquil

Both archaeological remains and the accounts of chroniclers during independence and colonial times have shown Guayaquil to be a population center that was born, grew, and developed architecturally using wood and guadua cane as the predominant materials in the construction of its dwellings. Historically,

> "...Early Guayaquil, because of the maritime commerce imposed by its geographical location, remained initially defined by its double function as provider of wood and caña for Lima and the other coastal cities of the Peruvian viceroy, and as principal port for the Audience of Quito..."[33]

As a port, it is well known that Guayaquil was the "...major shipyard in the Indies..."[34]; according to the Marqués de Selvalegre in 1754, craftsmanship and naval construction reached a state of near-perfection during the last two centuries of the colony.

Carpinteros de rivera was the name given the naval carpenters who, as the importance of the shipyards declined, began altering their trade. They even changed their names to "carpenters of the white" as they began to construct land dwellings, for which the precision of the cuts and joints of their old occupation was still necessary. This system of constructing wooden frames and walls of caña continued throughout the centuries, though later they would be covered with clay (*quincha*), and by the end of the XIX century, with galvanized sheet. One can still observe this system in construction in many sectors of the center of the Guayaquil.

Since the end of 1984 I have witnessed, through the action of local government, the demolition of numerous "old houses." I have observed that many of them, at first glance of concrete and brick masonry, had a wooden frame with walls of caña covered with a mortar of sand and cement - irrefutable evidence for the durability of those materials when properly used. During 1984 students in their first year at the School of Architecture of Laica Vicente Rocafuerte University took an inventory of the construction materials used in old houses built on the coast. There was not one coastal city that, among its houses 80 to 100 years of age, had not used wood and caña as construction materials; at the time of the inventory most were in magnificent condition.[35]

Our country has a population of approximately 8 million, half of whom comprise the urban population. The city of Guayaquil, with a population of 1.4 million, makes up 35% of the total urban population of the country. Of this total, approximately 600,000 inhabitants live in bamboo houses, or have in their buildings elements of this material. Enormous bamboo slums extend to the south, the west, and the north of the city. Their appearance is coincidental with the country's economic crisis and the lack of attention given to rural areas. Often called "squatter invasions," these uncontrolled settlements which appear between nightfall and daybreak are made from bamboo because it is the cheapest, lightest, and most adequate material available to the people of these cities. Consequently, bamboo construction has become a symbol of the misery and poverty of the country.

Precarious dwellings are constructed in mangrove swamps, with mud at low tide and water at high tide. The houses are connected by labyrinths of bridges, also of bamboo, that extend like interminable spiders of the mangrove, waiting for walls to be finished, and for the advent of electricity and public services; these are delivered in many cases according to the bribes and demands made by elected officials.

Figure 20. Suburb of Guayaquil. Bamboo houses, interlaced with bridges of the same material, raised above the swamp.

Guido Diaz says, referring to the uncontrollable growth of these dwellings, "...and they grow more quickly than plants..."[36], and like plants, they helplessly entangle the peripheries of small and large Ecuadorian cities alike.

In the year 2000, fifteen years from now, statistics and demographic projections show that Guayaquil will have a population of 3 million, with a need for 360 thousand living units. This means that it is absolutely necessary to confront housing problems not with conventional, uneconomical and inefficient systems, but by presenting alternatives that respond positively to our resources and to our traditions, and above all that better the quality of life of the people.

7. Floyd A. McClure in Ecuador

In 1945, Dr. Floyd McClure arrived in Ecuador as an agricultural advisor from the United States. According to his own account[37], the 16th of April, 1945 saw the first introduction of new species of bamboo to Ecuador. Eighty-five specimens of sixteen species of bamboo were flown to the Experimental Station of Pichilingue, Los Rios Province, today a division of the National Institute of Farming and Animal Husbandry of Ecuador (INIAP). Sixty-three of the specimens arrived alive.

Unfortunately the departure of Dr. McClure and the little importance that the federal technicians gave to the growing crop left few species surviving today. I must note that the species *Dendrocalamus asper* (Schultes) Backer, of which only one specimen arrived, has been reproduced with success in various sectors of Los Rios Province. The most notable cultivation of that species was begun in 1946 by Mr. Federico Von Buchwald, in the then Hacienda La Florida, today a military base of the Armed Forces of Ecuador.

Figure 21. Giant bamboo (*Dendrocalamus*) from Quevedo, Los Rios Province, introduced by Dr. Floyd McClure in 1945.

Figure 22. Clump of *Dendrocalamus* in Quevedo, Los Rios Province.

The attractive, beautiful plantation mentioned above was the motif of the poster of the Second Latin American Bamboo Symposium, which took place in Guayaquil in September of 1982, and which was well attended.

The contribution of Dr. McClure does not consist solely of introducing new species, but includes his innumerable observations on the use of bamboo by Ecuadorian peasants and its use in cities such as Guayaquil, Quevedo, and Manta. McClure compiled scientific and photographic material that appears in some of his works, especially in "The Bamboo as Construction Material,"[38] where he made valuable recommendations on its proper use.

8. First Experiments in Ecuador

Even though the entire history of the pre and post Columbian cultures of the coastal region of Ecuador had been linked to the use of guadua, little or nothing had been done to study the plant's taxonomy, cultivation, propagation and possible uses. It was considered to be a wild plant that naturally reproduced and grew; interest in studying it agriculturally, botanically, industrially, or as a construction material of social interest could not be found in a single profession or university. In 1970 a series of experiments was begun in Ecuador which I will now cite and accompany with a short commentary.

8.1. The Arnaldo Rufilli Laboratory of the University of Guayaquil

In January, 1975, a group of engineers from the Institute of Investigations and Advanced Studies (IIEA) of the School of Mathematical and Physical Sciences of the University of Guayaquil was asked by the National Housing Board to subject a series of bamboo specimens to physical and mechanical testing. The test results for bending, tension, compression, and impact were given in a report that, unfortunately, has not been published[39].

8.2. The National Housing Board and Bamboo

The government agency in charge of national housing has carried out a few experiments based on guadua.

8.2.1. Bamboo Use in Reinforced Concrete

Only a few slides[40] remain as evidence of the experiment carried out in the housing program of "La Pradera," where they constructed two houses using *latillas* of bamboo as concrete reinforcements instead of iron rods. The experiment was not followed up because the records of the house locations were lost, but so far there has been no news of defects or fractures in the program's houses, which indicates they remain in good shape.

8.2.2. Salto Program, City of Babahoyo

In 1976, across the river from the city of Babahoyo, Los Rios Province, a 154 unit housing program was completed with construction areas of 70 square meters in lots from 300 to 400 square meters. Constructed in three stages, using pillars of wood and then of concrete, they built walls and floors of caña, windows and doors of wood, and roofs of galvanized sheet. The houses were built on lands that were frequently flooded, but in 1984 their elevation was raised by means of hydraulic refill, which has radically changed the way the houses are settling. The value of the houses went from $1,900 to $2,400 in 1974[41].

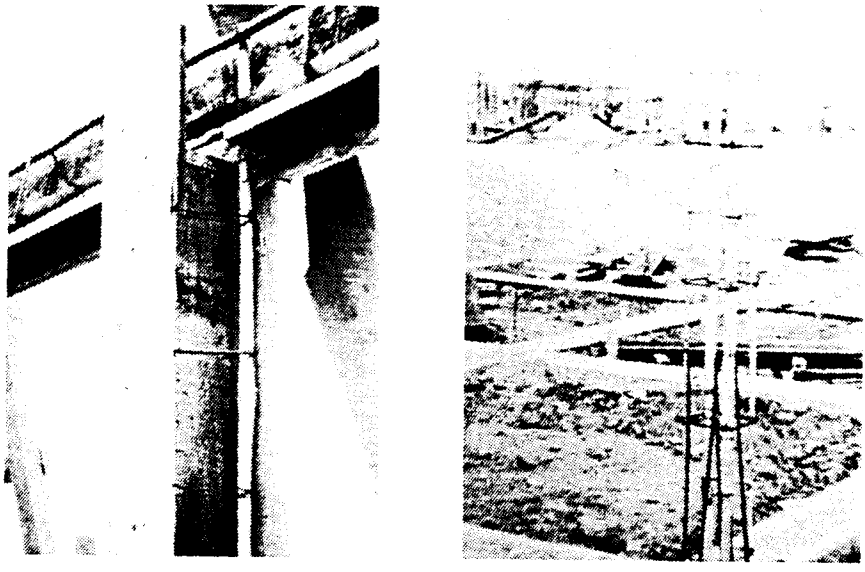

Figure 23. Use of bamboo as a substitute for iron, National Housing Board, "La Pradera" housing program.

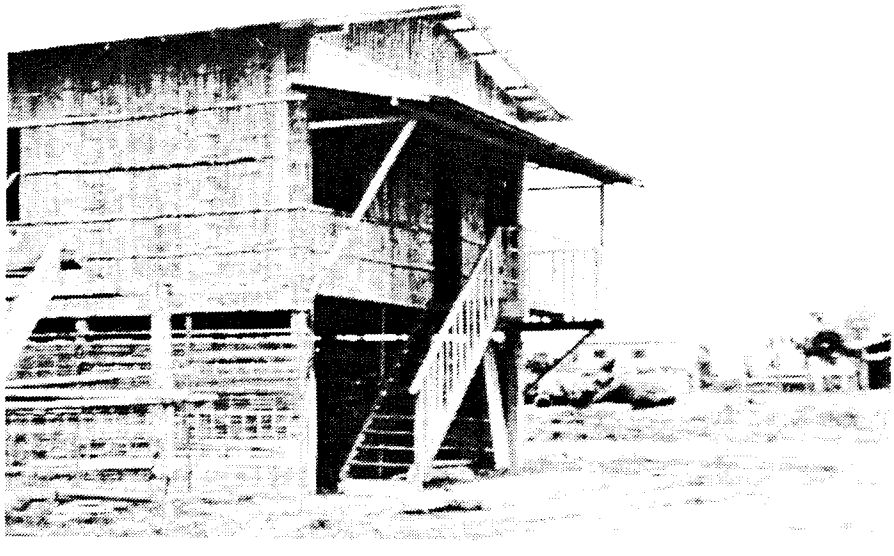

Figure 24. El Salto Housing Program, National Housing Board, Babahoyo, Los Rios Province.

8.2.3. Potosi Program, Esmeraldas Province

Also in 1974 the "Potosi" program, located in the city of Esmeraldas in Esmeraldas Province, came to a close. Financed by the Port Authority and CEPE (Ecuadorian State Petroleum Corporation), the National Housing Board constructed 62 units with living spaces of 46 square meters, each one on lots from 160 to 240 square meters, at a cost of $1,000 in 1974. The houses were built of simple blocks of concrete, with wooden frames, walls of caña, floors, doors, and windows of wood, and roofs of galvanized sheet[42].

To date the houses have deteriorated in form and condition and have not had their walls covered with mortar of any kind. Their poor appearance and deterioration, like the houses of El Salto, has contributed to the bad reputation and low prestige given bamboo houses in general.

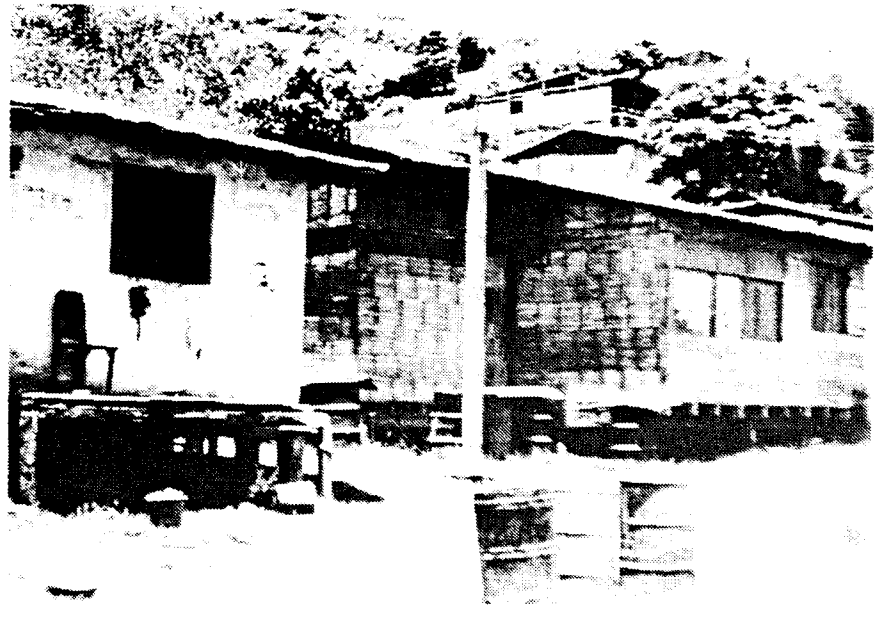

Figure 25. The Potosi Housing Program, Province of Esmeraldas.

The National Housing Board did not return to using bamboo in their housing projects until 1984 when they repeated its use in the Floresta II program overseen by Architect Oscar Hidalgo under the auspices of the United Nations. This program of barely 12 units was successfully carried out, and constitutes the beginning of the vindication of bamboo in Ecuador. I will analyze the program in a separate chapter.

8.3. The Patfoort Experimental Housing Program

Between 1981 and 1982 the construction of sixteen dwellings, financed by the United Nations and PREDESUR (Regional Development Program of the South) was completed. The technology and materials used, without a doubt, were more sophisticated than one usually associates with bamboo, which was used as a light material to support the elliptical tubes. Bamboo was also the material used for walls and certain furnishings

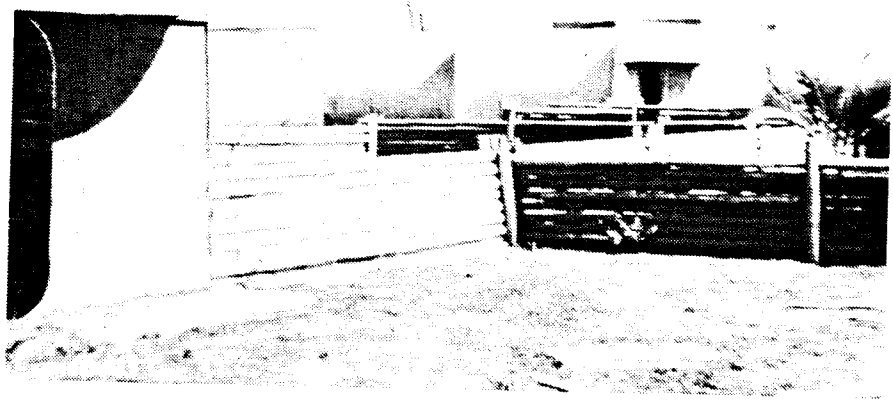

Figure 26. Experimental Program of Patfoort, Huaquilles, El Oro Provience.

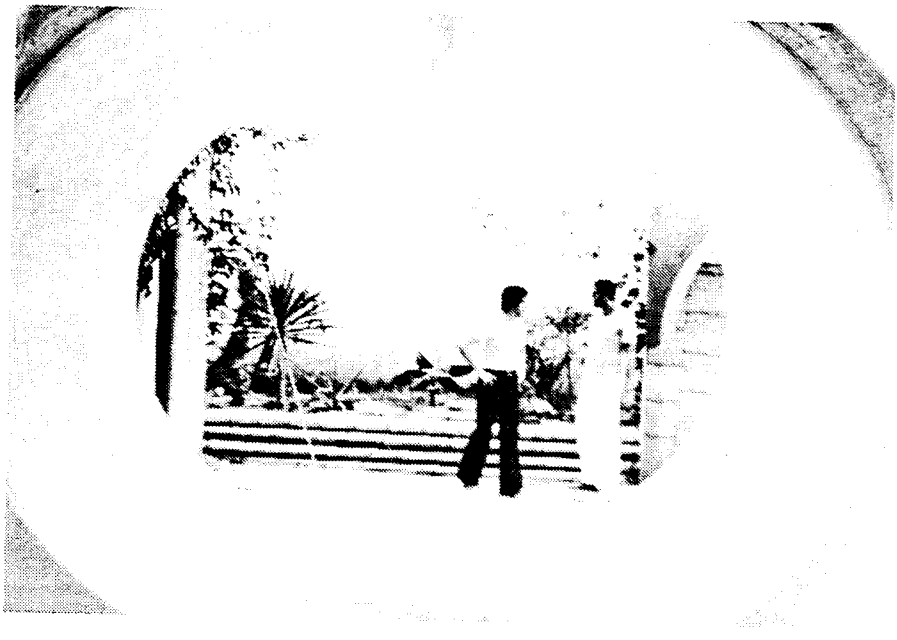

Figure 27. Experimental Program of Patfoort, view of one of the modules made from polyester resin and fiberglass reinforced with bamboo.

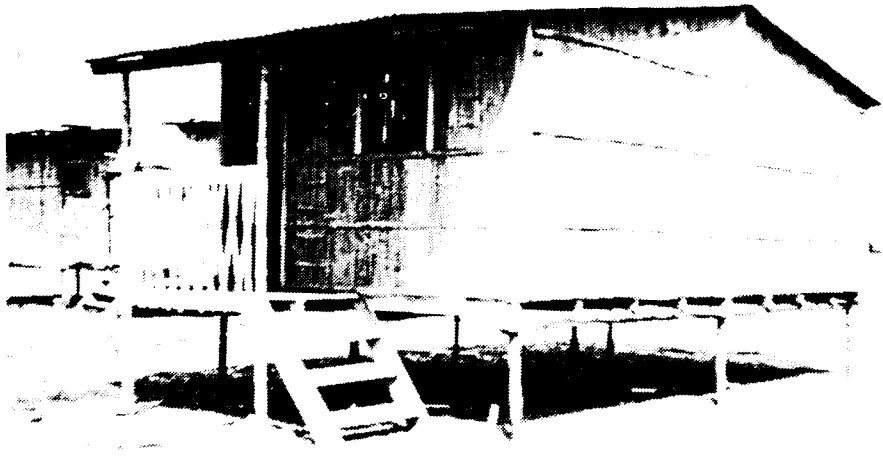

Figure 28. A Hogar de Cristo Corporation house, Guayaquil.

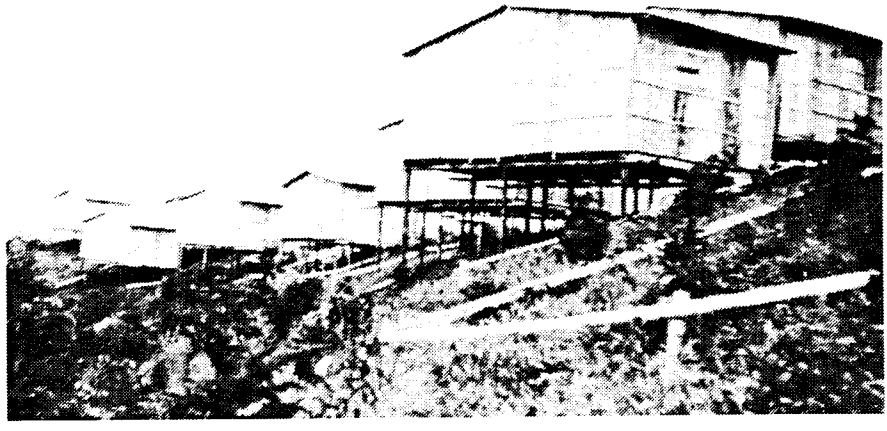

Figure 29. Hogar de Cristo dwellings, built in the settlement of Mapasingue, Guayaquil.

covered with fiberglass. The materials used other than bamboo were a polyester resin used as glue or cement, fiberglass as reinforcement, and finally, wooden floors. Each dwelling is made up of four modules or elliptical sections of tubes, with a uniform weight of 240 kg per module. The houses have a surface area of 56 square meters, on lots of 200 square meters.

The experience of the program indicates that this type of housing is feasible in an emergency, but not as something permanent, both because of the physical-thermal properties of the material and because the form of the modules was never accepted by the users, accustomed as they were to traditional forms. The building's value was $6000 in 1982[43].

8.4. Hogar de Cristo Housing Corporation

The Corporation is a nonprofit social institution. Its work was begun in 1970 by the priest Francisco Garcia S.I., who developed a housing program for low income families. The Corporation gives the beneficiaries prefabricated walls of bamboo, the frame of the roof, the roof of asbestos cement, the floor, doors and windows. The recipient prepares the foundation and raises the dwelling under the direction and control of the Corporation.

To date they have given more than 4,500 units to very poor families. Each house was worth $220 in 1984, which amounts to mortgage payments of $6 per month, making this among the cheapest housing in the world. The houses are of two types: 20 square meters and 40 square meters. The above costs are for 20 square meters giving a cost in 1984 of $11 per square meter per year. The Corporation also builds schools, community centers and convents. The walls of these houses are not covered with mortar.

9. Two Happenings

In August, 1981, supported by the National University of Colombia, the First Latin American Bamboo Symposium took place in the city of Manizales, Colombia, thanks to the help of Architect Oscar Hidalgo Lopez, professor of the School of Arts of the University of Colombia. I must here honor him and acknowledge his extraordinary efforts to popularize and further the study of bamboo.

The Latin American Association of Bamboo was set up, and with the presence of numerous delegates from all of the Americas, planned a date for a second symposium, this time in Guayaquil, Ecuador. In September, 1982, the Second Latin American Bamboo Symposium took place at the Laica Vicente Rocafuerte University.

The event had the backing of numerous institutions, and the presence of experts like Dr. Li of China, Dr. Cleofe Calderón of the Smithsonian, Dr. Ansio Azzini of Brazil, and architect Oscar Hidalgo himself among other scientists and 400 national and foreign delegates who attended. The event was reported by the national news agencies as being of high scientific value because of the quality of the exhibitions and the content of the papers.

For Ecuador in general and for the Laica Vicente Rocafuerte University in particular, the two symposiums offered more than sufficient reasons for initiating a series of studies and investigations, counting on the help of the International Development Agency (A.I.D.), Architect Oscar Hidalgo of the United Nations, the National Forestation Program (PRONAF) of the Ministery of Agriculture and Livestock of Ecuador, and other institutions and persons that understood the real scientific, economic and social value of guadua.

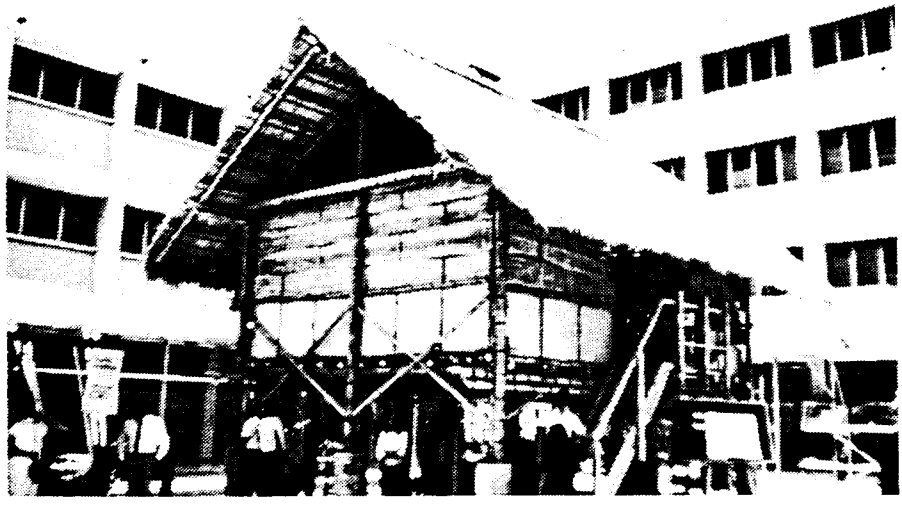

Figure 30. Experimental construction built in the Laica Vicente Rocafuerte University of Guayaquil by students of the Architectural School, for the Second Latin American Bamboo Symposium, 1982.

10. Investigations and Experiments at Laica University

10.1. Inventory of caña guadua in the coastal region of Ecuador.

Ecuador did not have an adequate record of the volume of natural guadua reserves in the country, or a summary of areas, which were or could be cultivated, either for industrial use or export. The A.I.D. and the Department of Agriculture and Livestock, through its National Forest Program, agreed with Laica University to undertake an inventory of resources, their geographic distribution and their growth habits in their native environment. The inventory was to conclude with a report describing methods and results.

Without further comment I will now list some of the results obtained by December of 1984. Guadua is distributed over a total area of 40,000 square km on the Ecuadorian coast of which 150 square km is accessible to commerce. The approximate number of plants is calculated at 27 million. Its natural habitat is defined by an altitude ceiling of 1200 meters above sea level and annual rainfall of at least 750 mm.

The major production of guaduas is in zones receiving between 1800 and 2200 mm of annual rainfall, which corresponds ecologically to very humid tropical forests.

The inventory found that the most common varieties are guadua *comun* or *mansa* (common or tame guadua) and caña *brava* (giant caña). It also found that the average caña has a diameter of 11 cm, a height of 14 meters, and a weight of 31 kg; the diameter ranges from 8 to 23 cm and the height from 11 to 23 meters. The average caña, when opened and flattened, covers an area of 4.5 square meters.

Figure 31. Laica University student constructing an experimental bamboo house, 1982.

Guaduas grow in small areas called *manchas* or clusters; of the 75,000 clusters recorded, 93% are smaller than 0.5 hectares. The size of the *manchas* ranges from 100 square meters to 10 hectares; there total area is 15,000 hectares. A conservative calculation of the number of plants per hectare is 1835 single canes, with actual counts ranging between 800 and 15,700. The inventory covered an area of 61,500 square km, almost the whole Ecuadorian coast[44].

10.2. Commercialization of Guadua

At the same time that A.I.D. and Laica University were taking their inventory of the wild guadua, they also studied its commercialization. They wanted to determine the types and commercial sizes of guadua at the producer level; the cost of transportation, cargo, and tariffs per kilo per km; points of destination; size, etc. They also determined the number of wholesalers, number of warehouses, earnings, profits, final destinations including those in bordering countries, and forms of transportation.

The resulting report established various key parameters, among which I emphasize the considerations the peasants traditionally use before cutting the cane, such as the period of the waning moon, low tides, and the small whitish growth areas on the cane - all signs that they study before harvesting the plant.

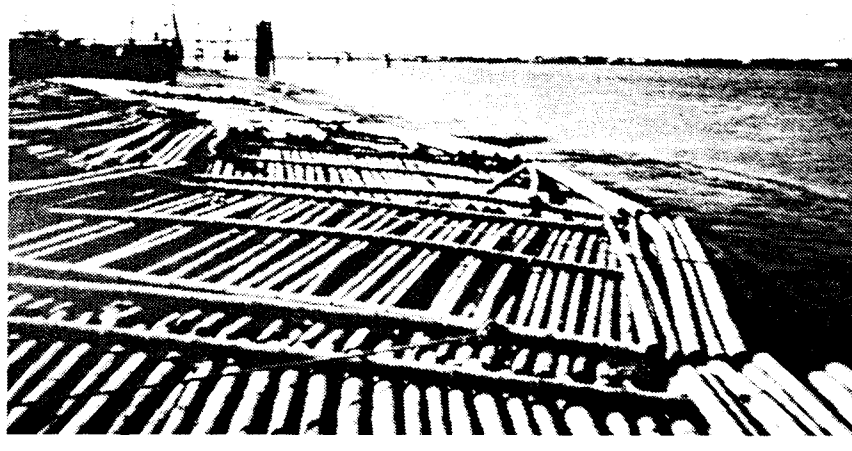

Figure 32. Transport of caña guadua through coastal rivers.

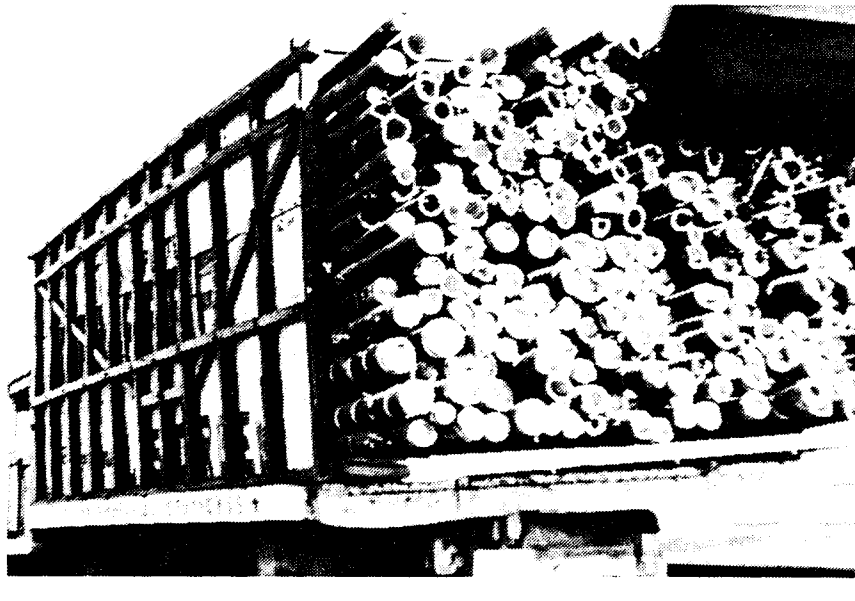

Figure 33. Transport of caña to Guayaquil and Peru using trucks.

The study determined a preference for the caña *mansa* because of the ease of cutting, transporting, and "working" it. Even though they realize that caña *brava* is more resistant than caña *mansa*, they feel it is more difficult to manage because of its spines.

Caña ready for market ranges in length from 6 to 8 varas from distributors in the cities, while at the haciendas they are between 16 and 18 varas. This produces an ample profit to the transporter-merchants who can obtain up to two units from each caña plus the tip of the bamboo, or *cuje*, which they sell to the banana plantations. They transport caña by truck and on a lesser scale by waterways as in times past.

In 1984, prices for a single cane ranged from $0.12 to $0.50 at the point of production and from $0.25 to $0.60 at the warehouse. Flattened canes brought from $0.03 to $0.06 more per unit.

It was found that two million units of caña were needed for the coast; 400,000 of these are destined for Peru, while the rest are for construction of dwellings on the outskirts of cities as well as for auxilaries to modern construction in the form of planking supports, painting and masonry scaffolding, etc.

I conclude from this study that although the cost of guadua has risen in the past few years, the increase has not been as great as for other materials in the construction industry such as iron and cement. This is because bamboo can be grown with little care. People in our country do not invest in bamboo cultivation; its production is completely natural[45].

10.3. Improvement of a House in Manta, Manabi Province

The tradition of using bamboo for dwellings has continued throughout the whole coast of Ecuador, but at the same time its poor utilization on the outskirts of cities and towns has produced considerable prejudice.

The city of Manta, through its mayor, Onofre DeGenna, Esq., solicited from Laica University and A.I.D. a model demonstration of how low income housing might be improved. They chose the neighborhood "20 de Mayo," situated on the edge of the city. The settlement consists of 300 similar dwellings built with bamboo walls. Two years after construction, they are a picture of misery and decay with a high fire risk. They are buried in dust in summer and flooded with rain in winter.

In October of 1984, a demonstration house was located. Its unemployed owner began the improvement work assisted by three neighbors and the occasional help of students from the School of Architecture of the University. The six member family moved to the back of the house and work began on the front using the material that remained in good condition and replacing the rest. They reinforced supports, changed a few floorboards, raised walls of bamboo, put up a smoothed ceiling matching the walls, added an inclined roof and erected a few sheets of asbestos cement to lengthen the eaves. They installed the electrical wiring and covered the house with a mortar of cement and sand. After putting in doors and windows, they painted the whole house.

The basic original design was not radically changed; at the end of three weeks, the house was much more comfortable. It was insulated, sanitary and secure. The cost of the improvements on 50 square meters was $500 in 1984. It is worth mentioning that the sanitary level was improved by constructing a small toilet from a bamboo frame covered with sand-based concrete.

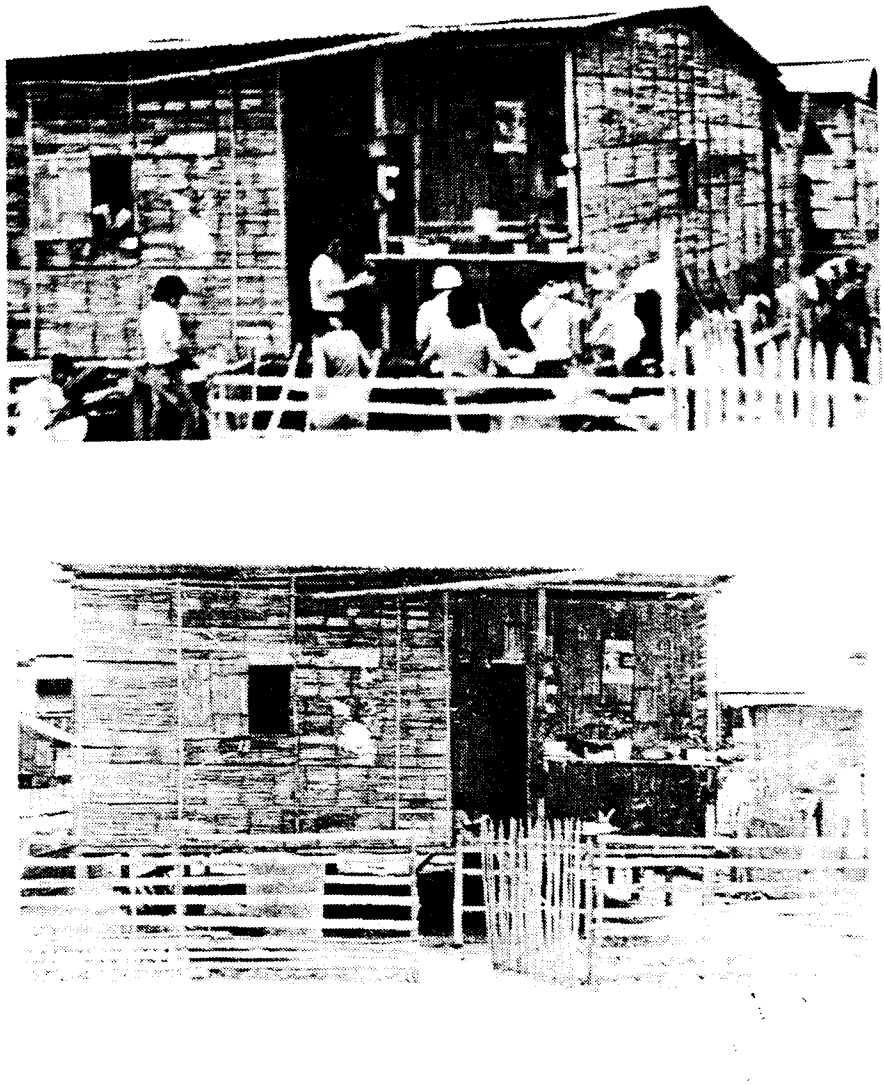

Figure 34. A house in Manta as it looked before improvement, October 9, 1984.

Figure 35. The same house after improvement, November 4, 1984.

10.4. A Communal House in Manta, Manabi Province

The success of the prototype caused the City to seek further support under the program for the construction of a communal house in the same "20 de Mayo" neighborhood. Construction began with the design of two levels that would serve as nursery and multiple use rooms. The supporting structure of the first level and the floor of the second level were built of wood. In the secondary beams they experimented with bamboo trusses in place of iron rods, following the experiments of Hidalgo[46]. The framework supporting the roof, like the wall-covering, was done with guadua *rolliza*. The walls and the ceiling were constructed with panels of bamboo. The roof was of galvanized sheet whose high heat conductivity was mitigated by installing level insulated panels as the ceiling. The walls were then covered with mortar of cement, lime, and sand, and to finish it off, were painted.

Today the building serves the community. The building covers 110 square meters at a total cost of $4,200 in 1985.

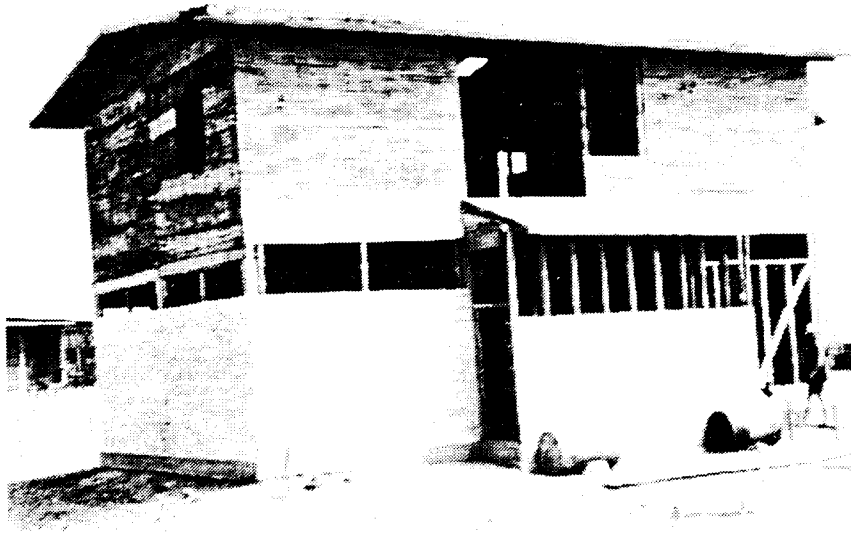

Figure 36. Communal house in Manta during construction.

10.5. Covering Bamboo Panels with Various Types of Mortar

Using traditional sand-based cement mortar to cover bamboo walls tends to create cracking. In February and March of 1985, A.I.D. financed an investigation of different types of mortars applied to bamboo panels. The investigation was carried out by Architect Oscar Hidalgo Lopez and myself. We wanted to establish which types of mortar would improve adhering conditions, lower the percentage of cement, retain optimal esthetic conditions as a covering, and diminish cost and weight of the panels.

Figure 37. Students from the Architectural School of Laica University building a frame of braided bamboo cables for use in a concrete beam.

Twenty-four experiments were carried out on a total of 400 square meters under rigorous control of variables (weight, volume, humidity, temperature, cost, resistance, etc,). Different combinations of materials were applied to open, flattened panels of bamboo set in different ways. Interesting preliminary results were obtained, and in the next months we will learn details of the investigation which no doubt will contribute towards improvements of bamboo construction techniques.

10.6. Study of Materials and Construction of Different Types of Peasant Dwellings on the Ecuadorian Coast

With the backing of A.I.D. and the United Nations, Laica University in 1984 completed an inventory of the materials and construction methods used by coastal peasants to build various types of housing. The main objective was to learn the peasant's traditional ways of using bamboo, to observe their ancestral construction techniques, to establish the basic parameters that they bring to the pragmatic design of their houses, which are extraordinarily conditioned to the environment, and finally to draw conclusions that permit the employment of their own technology, improved and more economical, for the design and construction of a house of social significance.

Figure 38. Investigation of bamboo wall coverings using different kinds of mortar, February, 1985.

Extensive field research took place, with the participation of students and professors alike, encompassing hundreds of cases, detailing properties of materials, in order to recover practical, and above all, Ecuadorian designs and systems. A.I.D has assumed compilation of the results along with similar focuses in other areas of the country.

11. Homes of the Shoemakers

With the cooperation of the United Nations and as part of the project ECU/79/006, the National Housing Board and the International Labor Organization (ILO) established a housing program, using bamboo, with Architect Oscar Hidalgo Lopez in charge as consultant from the United Nations for human settlements. He organized a housing construction program for twelve families whose oldest wage earners were all employed as shoemakers. The program was located in the neighborhood called "La Floresta," in the "Guasmo" sector to the south of the city of Guayaquil.

Over a compacted fill, perimetrical beams were joined to a framework of cables of braided bamboo. The foundation of the floor was poured over a rectangular mesh of bamboo. The walls were prefabricated, made from caña *rolliza* covered with caña *picada*. Reinforcing the dwelling, the walls were covered with a sand-based cement mortar, and painted with carbide.

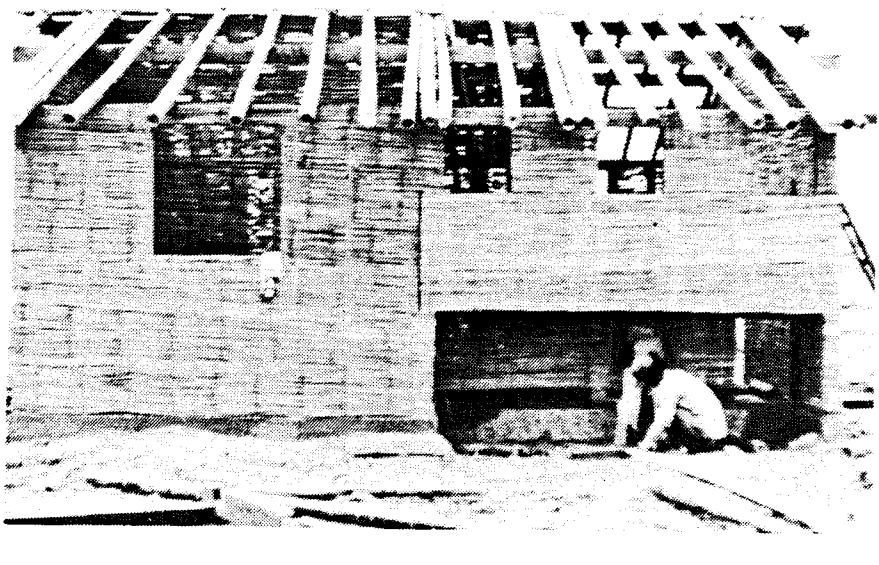

Figure 39. Construction of prefabricated houses of bamboo, "La Floresta" program, Architect Oscar Hidalgo Lopez, Guayaquil.

The doors and windows are of wood; the asbestos cement roof is supported by a bamboo framework covered by flattened bamboo both above and below. The dwellings were built on the perimeters of the land, leaving in the central part a space for future construction.

Architecturally, a flexible design was chosen and adapted to the specific needs of the occupants and site. The basic model of 3.2 x 6.4 meters might vary up to 34 and 41 square meters. The cost per square meter was $42 in 1984.

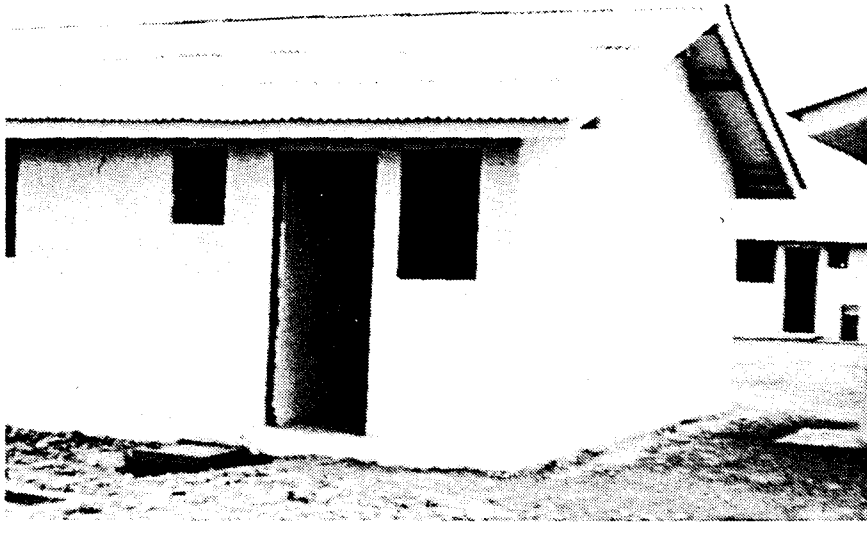

Figure 40. One of the twelve shoemakers' houses, "La Floresta" program, Guayaquil.

The houses have a pleasing esthetic aspect, and are efficient and comfortable because of the air chambers in the walls. Without doubt this is one of the best bamboo-based programs in Ecuador because of the sensibility of the system of prefabrication, completion and mounting which requires no specialized craftsmanship or equipment.

The use of guadua, a natural resource of the country, and of other techniques adapted to the needs of the people of the suburbs of Guayaquil, together with the low cost of bamboo housing, give a positive alternative solution to a grave housing problem.

12. Final Commentary

This document has not tried to be quantitatively exhaustive, but rather qualitatively representative. I have summarized the use of bamboo in Ecuador through the ages, emphasizing the first effective steps toward the rescue, conservation, cultivation and propagation of one of the most used and at the same time least understood natural resources of the country.

I am completely convinced that by using conventional systems of construction and reducing areas, heights, etc., we will never be able to design homes for, and worse, to provide homes to coastal Ecuadorian peasants. To think otherwise is cruel and utopian, especially now that the economic situation in Ecuador and the demand for houses are inversely

proportional; buying power is diminishing as the need for houses is progressively increasing.

What is the answer? To continue to use alienating and anti-human construction materials for our hot and humid climate? Sheets of reinforced concrete for walls and roofs? To further reduce the already miniscule vital space for the family? Or is it not more fair and logical to look for alternatives among our own natural resources, with our own technology and design, of such form that together they permit us to glimpse some solution to the now grave housing problem that not only affects Ecuador but all the countries of Latin America.

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