

BAMBOO HOUSING IN COSTA RICA: AN ANALYSIS OF A PILOT HOUSING PROGRAM

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Abstract

This research study identifies and evaluates social/cultural, physical, and economic parameters that impact the use of bamboo as an indigenous construction material for low-income housing in developing countries. A post-occupancy study was performed utilizing a pilot housing project for low-income Indian families in Costa Rica. Participant-observer analysis of interior and exterior design elements based on cultural/social, physical, and economic parameters was included. A combination of interview, questionnaire, visual documentation, and site observation techniques was utilized. The findings served as a basis for proposing improvements in design and philosophy that could be used with bamboo housing projects for low-income families.

Qualitative and quantitative results indicated that bamboo is an acceptable, low-cost, locally available, renewable material which lends itself to self-construction methods. If housing project directors carefully consider the needs, values, and views of inhabitants, bamboo is a useful material in the provision of adequate, affordable, and culturally acceptable housing in developing countries.

Introduction

The housing problem in developing countries is colossal. Solutions to the problem have been plaguing the governments of these countries for decades, and it appears that there are no easy answers. The causes of the problem are basically threefold: explosive demand for housing fueled by fast growing populations and migration into major cities of the developing world; an economically and politically restricted supply of affordable buildings and materials in the housing sector; and the growing poverty in developing countries. "The number of people living in absolute poverty in the early eighties is estimated by the World Bank and U.N. Food and Agriculture Organization (FAO) to be between 700 million and one billion" (Durning, 1990). Since that time, poverty has increased dramatically in Africa, Latin America, and parts of Asia, so that worldwide, the number estimated to be living in absolute poverty is 1,225 million, or 23% of the earth's total population (Durning, 1990). With the amount of their incomes deteriorating, families simply do not have the means to house themselves adequately. It is estimated that one hundred million people have no shelter and that approximately one-fifth of the world's population is inadequately housed in slums and shantytowns (United Nations, 1986).

Few workable solutions to Latin America's housing problems have emerged in the past few years. Governments realize the importance of a good home environment, but also realize that many other needs of their citizens must be met--employment, food, clothing, security, health, education, transportation, and communication. Because housing takes a great proportion of a government's limited resources and visible results are slower to appear, precedence has often been given to solving other problems first.

Early attempts at providing the poor with traditional housing units constructed from modern Western materials failed, partly because of basic arithmetic: often a country's resources could not equal the need for housing units. Over-designed public housing units were promoted under the mistaken notion that solid houses built utilizing Western designs

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and imported materials were the definitive answer to housing the masses (Turner, 1977). A recent shift in Costa Rican housing policy is encouraging the utilization of available resources such as indigenous materials, construction skills, and transportation systems, as well as allowing families to be responsible for the construction of their housing.

One answer to improved housing may lie in the resurrection of indigenous architecture --buildings which rely on available materials and on the traditional building skills of the people of a locale; buildings which do not require costly imported materials, extensive transportation and consequent overspending of the national budget; and buildings which do not sacrifice human freedom and dignity by their existence (Cain, 1976). Appropriate economic housing policies can assist low-income families in solving their shelter problems.

Throughout history, indigenous housing has permitted the use of natural and renewable resources and encouraged families to be facilitators in the development of their housing. One of these available resources in Costa Rica is bamboo (Hartkopf, 1985). Bamboo is plentiful and inexpensive in certain areas; people can construct their housing using simple tools; traditional skills and methods are used; bamboo is easily harvested and needs no finishing before use; bamboo housing is easily built, sturdy, and earthquake resistant; and bamboo can be used in all aspects of building construction, including reinforcement of concrete in foundations, and as posts, wall framing, roof tiles, doors, window frames, and furniture (Farrelly, 1984; United Nations Centre for Human Settlements, n.d.).

Traditional Latin American bamboo construction techniques have included various uses of unfinished bamboo poles: bahareque, a type of wattle and daub construction in which a bamboo frame is coated with a mud/straw mixture applied to the surface of the structure; embutido, a variation of bahareque in which bamboo strips are fixed horizontally to both sides of bamboo posts and this frame filled with stones or earth or a mixture of the two (Rubbo, 1977); and quincha, a sprung strip construction in which flexible strips of bamboo are woven together to provide a base for the mud/straw plaster which is applied over it (McClure, 1981).

From the colonial legacy of construction comes an architectural dualism which continues today. Colonial elites demanded Western standards in housing and use of imported materials. Prestige was indicated by tile, brick, and concrete instead of adobe, thatch, and wattle and daub construction. Thus, a cultural bias against bamboo housing held by many low-income people must be addressed before such housing could be considered acceptable.

Recently, the use of bamboo in low-income housing construction has gained momentum (McClure, 1981). One three-year, three-phase project was sponsored by The United Nations Centre for Human Settlements (HABITAT) and the government of Costa Rica, with funding from the government of the Netherlands.

Phase One, begun in late 1988, involved the cultivation of *Bambusa quadua*, a preferred bamboo species for construction throughout the Americas because of the large diameter of its culms (stalks), strength, and greater resistance to wood-eating insects. By the end of 1992, a total of 700 hectares (1,729 acres) had been cultivated in test plots in different areas of Costa Rica.

Estimates are that the bamboo will be ready for harvest and use in housing construction in 1995, seven years from initial planting (J. Gutierrez, personal communication, December, 1989).

Phase Two, begun in 1988, involved the construction of 500 new low-income dwellings and the repair of 50 dilapidated and inadequate dwellings using both the native *cana brava*, a prolific weed similar in form and appearance to bamboo but not actually a species of bamboo; and *Bambusa vulgaris*, another of several species of bamboo especially suited to housing. The first 93 houses were built in southern Costa Rica in the Indian communities of Terraba, Curre, and Boruca where annual precipitation is approximately 158 inches and annual average temperature is 75 degrees Fahrenheit (Hall, 1985). Similar houses were built in other parts of Costa Rica as well.

Phase Three involved training of the 550 families in the use of *cana brava* and *Bambusa*

vulgaris, in the cultivation of bamboo, and in house construction methods. Self-help construction was promoted and technicians were assigned to the communities to work with families at each stage of construction. The concept of self-help is not new, although it was not commonly accepted in the United States until it was successfully adopted by Habitat for Humanity, a U.S. based non-profit group which mobilizes individuals and communities in working together to build housing for low-income families. Worldwide, self-help housing has been endorsed by international housing experts such as Turner (1977) and has acquired powerful backers such as the World Bank and Agency for International Development (Ward, 1982).

More knowledge of, and exposure to, indigenous technologies and materials such as bamboo will assist housing development professionals in improving low-income housing.

The overall objective of this study was to identify and evaluate social/cultural, physical, and economic parameters which contribute to and impact the use of bamboo as an indigenous construction material for housing in three Indian communities within Costa Rica: Terraba, Cure, and Boruca. These communities were chosen because they were considered by the Costa Rican Ministry of Housing to contain some of the poorest housing in the country.

Methodology

Families living in 45 bamboo dwellings constructed as part of the Costa Rican National Bamboo Project in the three Indian communities, and who had occupied these dwellings for periods ranging from two to 16 weeks, were randomly selected from Bamboo Project lists. Data were collected for this post-occupancy, participant-observer evaluation by the researcher during a period of residence in a bamboo house in one of the Indian communities. Four types of data were collected:

1. An informal interview instrument was utilized for obtaining data from National Bamboo Project personnel before on-site interviews began.
2. A Homeowner Satisfaction Questionnaire containing both closed- and open-ended questions was administered orally in Spanish to the head of the household at each of the 45 houses. Thirty-five of the heads of households were male; ten were female. The number of persons living in each household ranged from one to eleven and ages varied from newborn to over 71 years. An assistant interviewer, familiar with all aspects of the three Indian communities and fluent in Spanish, assisted in the administration of the questionnaire.
3. On-site visual documentation included photography, which was utilized for documentation of the characteristics of the housing and floor plan sketches. These sketches illustrated the original plan as well as the type and placement of any additions made either during construction or after completion of the basic house.
4. Researcher observations included changes made to increase cultural/social acceptance or to meet economic restrictions of the built environment.

Data Analysis

According to Salmen (1987), persons working in the area of international development are not best served by acquiring statistical proof to assist them in making good decisions. Familiarity with cultural, social, economic, environmental and other factors are of more value in making decisions which will positively affect development. Thus, for this study, simple qualitative and quantitative techniques of analysis were utilized in assessing data. Frequency counts and percentages were tabulated for general information and demographic characteristics (gender, number of persons living in the household, age, number of persons in residence during daytime and evening hours, supply of labor for house construction, type of fuel used for cooking, number of weeks of residence in the new house, primary source of water) and design aspects (adequacy of house and room size; placement of rooms; desirability of glass windows, porch, paint color, roof material and ceiling material; placement of windows and doors; and changes to the original floor plan). Data on housing design factors were accumulated on a Homeowner Satisfaction Questionnaire. Interview and visual infor-

mation (i.e. photographs and floor plan sketches) were analyzed. Systematic participant observations recorded by the researcher were used to augment questionnaire and interview data.

Findings

Design

Floor plans of houses totaled 419 square feet, regardless of family size, and included a bathroom, a porch, two bedrooms, and a multi-purpose room. Even though small by North American standards, in tropical climates a family's living space is always expanded to include the immediate outdoor area. Household size averaged six members and ranged from one to eleven members. On the Homeowner Satisfaction Questionnaire, one half of the respondents stated that the size of the house was inadequate. Information given during the informal interview of Bamboo Project personnel indicated that the original plan developed by the National Committee for Indigenous Affairs was utilized with no modifications or input by homeowners-to-be. The plan is shown in Figure 1, and the completed bamboo house in Figure 2. An inside kitchen was originally included in the plan since Costa Rican law requires house plans to include a kitchen and bathroom. This was not, however, practical for the Indian communities in which traditional cooking methods with an open wood fire are practiced. Results of the Homeowner Satisfaction Questionnaire indicated that over 95% of the families did not want the kitchen inside the house because of the soot and heat generation. Because the kitchen placement problem was perceived during construction, Bamboo Project personnel provided additional materials for construction of an outside kitchen. Solutions to kitchen placement varied; some were to be added as additions to one side of the house (Figure 3), others as a separate building (Figure 4).

The porch was considered an important inclusion by most families--44% of the respondents to the Homeowner Satisfaction Questionnaire chose the porch as their favorite room. However, some families did close in their porch or reduce its size in order to provide more enclosed living space. Bathrooms opening off the porch were considered a minor problem in design.

Construction

The informal interview with Bamboo Project personnel revealed that self-construction and self-management were chosen as the preferred methods of construction in order to enhance the social and economic fabric of the Indian communities (Gutierrez, 1989). Participants were trained in simple but appropriate technologies and monitored by technicians. Four to five families worked as construction teams, finishing a construction phase of all of their group's houses before moving to the next phase. An advantage of the self-help method was that participants developed expertise in this type of construction which later could become a source of family income. Results of interviews showed that workers perceived bamboo construction as being slow, difficult, and complicated. In addition, self-help construction was not always desirable for subsistence agriculture economies. Because of the need to construct houses, family members were not able to work in their fields and bring in a harvest--thus no income was earned, but food still had to be purchased. The Bamboo Project assisted families with this problem by donating food and loaning money to participants for the purchase of food during the construction period.

Materials

Foundation/floor. Concrete was the material used in all but seven of the more inaccessible houses. A concrete sealer was painted onto the finished floor. Concrete was a new material to householders, dirt serving as flooring in previous houses. When residents were asked on the Homeowner Satisfaction Questionnaire whether they liked the concrete floor, only eight responded that they did not. Comments were made that it was much colder than dirt on bare feet, it required more frequent cleaning, and that products for upkeep were an economic drain.

Roof. Corrugated galvanized steel (lamina) supported by timber trusses, was used on all houses since no other suitable low-cost material was available. Research is currently un-

Figure 1. Floor Plan, Indian communities.

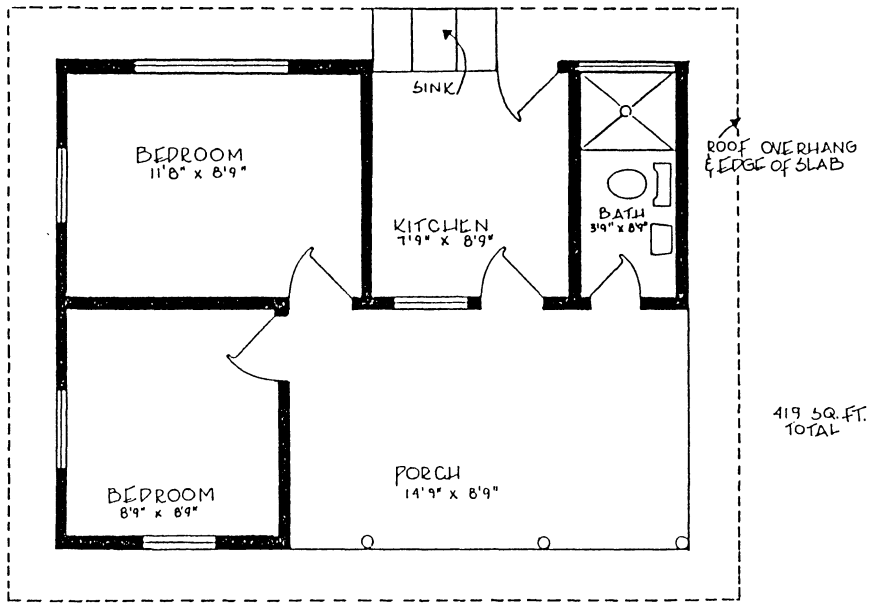


Figure 2. Completed bamboo house, Indian communities.



Figure 3. Kitchen addition at one end of house.

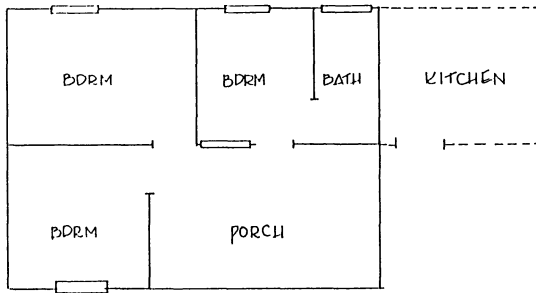
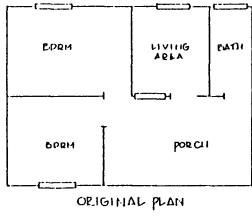
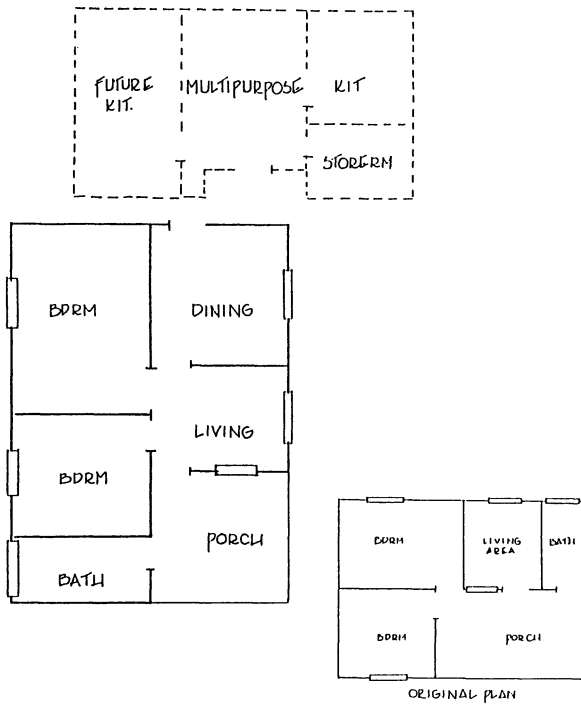


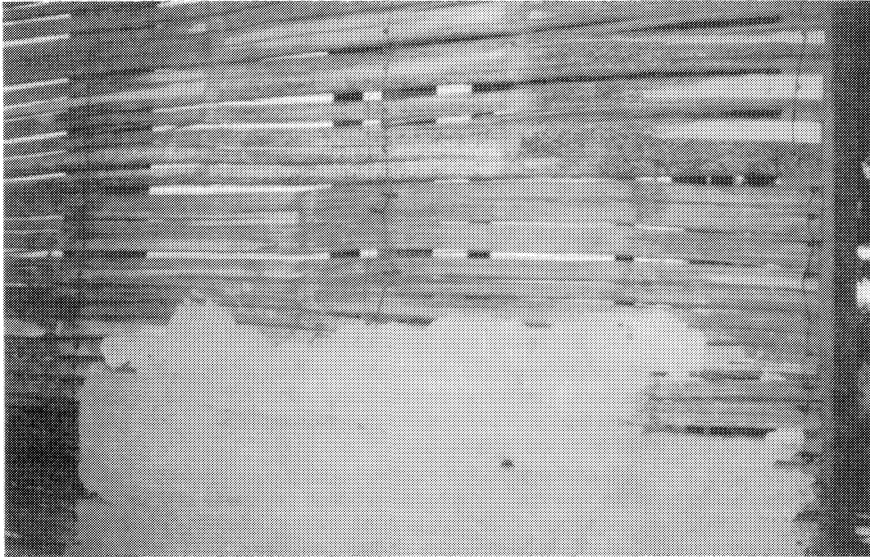
Figure 4. Separate structure being built to house a kitchen and several other rooms.



derway in the use of vegetable fibers for roof panels which could reduce the cost of roofing. Wooden trusses were left uncovered and visible so that air movement could cool the house. As *Bambusa quadua* matures in cultivation plots, it will be used instead of wood for trusses. No ceiling was installed, partly to allow air movement and partly for economic reasons, although on the Homeowner Satisfaction Questionnaire 71% of respondents said they would eventually like to have a ceiling. Most felt that the houses were cool and that placement and number of windows and doors allowed adequate air movement.

Walls. Structural frameworks for the houses were made of timber, since *Bambusa quadua* was not available in Costa Rica in great enough quantities for large scale construction projects. It is currently being cultivated in various parts of the country and when mature will be used for framework instead of increasingly scarce and costly timber. *Bambusa vulgaris* was used for wall sheathing in the form of esterilla, a construction material formed by opening bamboo culms into flat "boards" by splitting the culms lengthwise along one side and pressing them flat (Figure 5). Cana brava was also used in some communities.

Figure 5. Wall studs covered with esterilla.



In order to combat bamboo's susceptibility to rot fungi and invasion by wood-eating insects, esterilla was soaked in an anti-insect and anti-fungal solution of Xilobor before use in construction. Researchers have studied means of insect proofing and otherwise improving the durability of bamboo with other methods, including reducing starch content (Farrelly, 1984; McClure, 1981; United Nations Centre for Human Settlements, n.d.), and exposure to heat and wood smoke and burying in sand (Farrelly, 1984). In humid areas, fungal growth in the grooves of the bamboo canes is also a problem (Agency for International Development, 1985).

During construction, the esterilla was covered by several coats of a cement/sand mixture and painted white. The cement/sand covering was employed for two reasons: to help protect the bamboo esterilla from insect and rot damage due to weather, and to improve cultural acceptance of bamboo as a housing material since the house ultimately appeared more "high status." On the Homeowner Satisfaction Questionnaire, all but three families indicated that they were pleased with the overall look of the house, although 62% of the respondents disliked the white paint because it dirtied easily. Brown paint was used around the base of the house to help counteract this effect, but some families chose to use the brown paint to create decorative motifs on the exterior walls of the house.

Doors/Windows. Three wooden doors, one lock, and four sliding two-paned glass windows were provided for each dwelling. Glass was chosen over the traditional wood windows because it was considered to be of higher status (Gutierrez, 1989). When asked on the Homeowner Satisfaction Questionnaire, 35% of the homeowners indicated that they did not like glass once the house was completed. Reasons given were that glassed openings cut air circulation, posed danger for children, killed birds and chickens that flew through the openings and broke the glass, caused economic hardship when glass had to be replaced, and limited security in that glass could be easily broken by intruders.

Plumbing/Bath. A septic tank was connected to the kitchen sink, bathroom sink, and toilet. The house was also connected to a community water supply. According to Homeowner Satisfaction Questionnaire findings, in four cases the bathroom was deleted from the original plan and placed in an addition on the back of the house. These respondents stated they did not want inside bathrooms. Although not specifically stated, it was assumed that these families preferred the traditional remote "outhouse" location for cultural/social reasons. In the original plan, the bathroom was placed on one side of the house rather than next to bedrooms where its opening would have been centered on the porch which would be used for entertaining. Several families modified the plan so that the bathroom door opened instead onto the back yard of the house or into a bedroom.

Electricity. Researcher observation indicated that two Indian communities had electricity and each bamboo house had an operational electrical system. In the third community, houses were wired in anticipation of having electricity.

Cost. Information gathered from the informal interview given to Bamboo Project personnel revealed that the total cost of materials for each dwelling was approximately \$2,500. The monthly cost of repayment to the community by the family was \$3.90 for the first year, and \$4.70 for the remaining 15 years. Households headed by women had an additional three years to complete payment. Monies repaid were to be placed in a community improvement fund. According to the Homeowner Satisfaction Questionnaire, families felt that they would be able to meet yearly re-payment costs.

Summary and Conclusions

Bamboo is a low-cost, locally available, renewable material which lends itself to traditional, self-construction methods. The home-owners in the Indian communities were generally satisfied with the physical design of bamboo houses, although overall size was deemed too small and exterior white paint impractical.

The objective of providing affordable low-income housing was met since homeowners believed they would have the financial ability to make house payments over the repayment period. In addition to providing housing for their families, skills in bamboo construction technology were developed, thus providing for future income-generating skills by individual family members.

Socio-cultural acceptance of the project was generally successful in that the self-construction aspect tended to enhance the social fabric of the Indian communities and encourage reciprocity patterns of assistance. One negative aspect was that the self-help method limited the time the subsistence farmer could devote to providing the family's food. Cultural bias against what was perceived to be low status bamboo housing was successfully countered by covering the bamboo esterilla with a cement/sand mixture, thus approximating the stucco finish popular in Western housing. In this Costa Rican Indian society it was culturally desirable to include an outdoor living area--in this case a porch--in house design and to include glass windows, although the latter subsequently was proven to some extent to be uneconomical and culturally unacceptable, a fact not realized at the onset of the project. Because of the cultural tradition of cooking over an open fire, kitchens were not successfully placed in the original design and had to be relocated during actual construction.

Understanding the needs, values, and views of the beneficiaries in any housing project is important to ensure the success of that project in its cultural context. The Costa Rican National Bamboo Project directors, realizing the fact that housing is more than simply physical structures, used a multi-disciplinary approach to house production. Professionals and spe-

cialists from the fields of architecture, forestry, engineering, agriculture, and social work each provided their varied expertise in both the planning and execution of this project. In addition they worked with, rather than around, the beneficiaries, consulting them whenever possible and effecting changes as problems were encountered. More extensive consultation was planned for future segments of the project.

If the success of this housing project in Costa Rica is an indication, utilization of bamboo may become an answer to the housing crisis in developing countries. Specialists in low-income housing, as well as homeowners themselves, are beginning to realize its physical capabilities, as well as its environmental and cultural appeal.

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