THE ROLE OF IMPROVED INDIGENOUS BUILDING MATERIALS AND CONSTRUCTION TECHNIQUES IN LOWERING THE COST OF HOUSE CONSTRUCTION (A CASE STUDY OF A DEMONSTRATION HOUSING PROJECT IN HAKATI AND MBITA DIVISIONS OF WESTERN KENYA)

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DECLARATION

This thesis is my original work
and has not been presented for
a degree in any other university.

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This thesis has been submitted
for examination with our
approval as University Supervisors.

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ABSTRACT

As in many other developing countries around the world the need for housing in Kenya's urban and rural areas, which is predominantly characterized by insufficiency both in terms of quantity and quality, is growing at a faster rate than it can be satisfied. Its growth can be attributed to many different factors, but one of the major ones is that the cost of conventional house construction continues to rise above the ability of most people in Kenya to pay for such housing. In fact, rising construction costs can be directly attributed to increases in the cost of building materials and labor which account for nearly 82% of the total cost of a conventional housing unit.

Realizing that the total cost of house construction can be decreased significantly by decreasing the cost of these two elements, many housing research organizations around the world have been investigating the degree to which the use of low-cost local building materials and construction techniques and local community participation can reduce the costs of house construction. In Kenya, the Housing Research and Development Unit at the University of Nairobi has demonstrated the use of stabilized soil-cement blocks, corrugated sisal-cement roofing sheets, and local community participation in the

construction of ten teachers' houses in Hakati and Mbita constituencies of Western Kenya. The purpose of the demonstration project, also known as the Improved Rural Technology (IRT) project, was to transfer appropriate low-cost housing construction technologies to rural communities and establish some means (in this case housing co-operatives) through which the communities could continue to replicate the technologies in the construction of more teachers' houses in the future.

This study examines the degree to which the use of improved indigenous building materials and self-help labor in the IRT project was actually able to lower housing costs. However, since the total cost of each housing unit was dependent on many factors such as the speed of project implementation, the quality of the houses, and the degree to which original project objectives were achieved, the role that appropriate technologies and community participation played in lowering the cost of house construction is evaluated in light of these factors.

An evalaution of the IRT project reveals that the use of soil-cement blocks and sisal-cement roofing sheets which are produced on site can reduce the cost of conventional house construction by approximately 26% and yet maintain a high standard of housing quality. Because of the technology's local acceptability, appropriateness, and reasonable cost for teachers' housing; the housing co-operatives in the two constituencies plan to continue to use the technology in constructing more teachers' houses in the future. But in order to increase the efficiency of future replication activities, some changes will need to be made in the organization of the co-operatives and the procedure to be followed by them in constructing more teachers' houses. Recommended changes are presented in Chapter 6.

In terms of reducing the cost of labor associated with the house construction process, the evaluation reveals that the IRT project was not a good demonstration of how local community participation can lower housing costs. In this project there was minimal community participation; both skilled and unskilled tasks were performed on a paid basis. Because of the need to pay unskilled workers and the low productivity of both skilled and unskilled workers, the total project expenditure on labor was nearly 8.5 times higher than had originally been expected. Hence, the cost reduction normally associated with the involvement of local people in house construction on a self-help basis never materialized in this particular project.

The use of improved indigenous building materials and community participation can play a significant role in reducing the cost of conventional house construction. When incorporated in other low-cost housing programs such as site-and-service schemes and settlement upgrading, these two concepts will certainly contribute to the provision of housing which a greater percentage of the people in Kenya can afford.

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Statement of the problem

"Can the different countries of the world succeed over the next 25 years in building as many houses as the human race has succeeded in building over the past 10,000 years?"[1] This question which was raised at the United Nations Conference on Human Settlements held at Vancouver in 1976 indicates the tremendous magnitude of the number of houses that will have to be built in the coming years to accommodate the world's rapidly increasing population.

In fact, more than 500 million houses have to be built between 1980 and the year 2000 to house the people of the developing countries. It was estimated in the early 1970s that the developing countries needed to build over 8 houses per 1000 per year. In 1970, figures from 24 countries indicated that they were building only 1.8, and Agarwal states that there is little reason to believe that the rate has improved substantially since then.[2] Given these facts one can conclude that the need for housing is great; the rate at which the need is being met is negligible; and the situation is not likely to improve significantly in the foreseeable future as long as the present trend continues.

Urban Areas

The housing problem manifests itself differently in the urban and rural areas of most developing countries, and consequently, the two areas can be discussed separately. In urban areas inappropriately high housing standards requiring that houses be built with conventional building materials (e.g. stone, bricks, or concrete blocks) raise the cost of housing to unaffordable levels. For example, the World Bank has estimated that 35% of Hong Kong's households, 47% of Bogota's, 55% of Mexico City's, 63% of Madras's, 64% of Ahmedabad's and 68% of Nairobi's cannot possibly afford the cheapest approved dwelling that can be built.[3]

Because of the high cost per unit, even the combined effort of the public and private sectors is not able to provide the number of housing units needed. Consequently, the housing need has been growing in most developing countries. Housing need can be defined as follows:

> the extent to which the quality and quantity of existing accommodation falls short of that required to provide each household or person in the population, irrespective of ability to pay, or particular personal preferences, with accommodation of a minimum specific standard and above.[4]

In 1977, Morocco had a need of more than 800,000 houses. The Philippines had a housing need in urban areas of nearly one million in 1977. Egypt's urban need in 1975 was more than 1.5 million housing units. Nigerian officials estimate that the need in 14 cities is about 400,000 houses.[5] In Kenya, the 1984-88 National Development Plan estimates a need in urban areas of 275,200 units. However, the expected output during the plan period is only 59,504 units. This level of production has little impact on the existing need and does not even begin to address itself to the housing need resulting from the increasing size of the population.[6]

Because there is a shortage of housing in urban areas and because people need shelter of some type; they resort to building houses with whatever materials are available and in whatever space is available, thus resulting in unplanned settlements characterized by severe overcrowding and housing of low quality. Several developing countries report that there are three or more people per room in more than 40% of the housing in their countries.[7] In 1981, 65% of the people living in Dar-es-Salaam were living in slums, shanty towns, and other uncontrolled settlements. In 1978 in Lusaka, it was 48%. In Lagos, 83% of the people were living in uncontrolled settlements in 1978. And in 1984, 33%

of the people living in Nairobi were living in uncontrolled settlements.[8] In summary, the housing problem in the urban areas of most developing countries is predominantly characterized by insufficient quantity and low quality.

Rural Areas

In the rural areas of most developing countries there is a reliance on the use of traditional building materials (e.g. mud-and-wattle walls and thatched roofs), and as a result, the overall quality of housing is low. Of course, a house built with these materials is about the only type that most rural families can afford. In fact, more than 75% of all rural households in developing countries cannot afford to purchase even the cheapest modern house.[9] A second factor which contributes to this reliance on traditional materials is that the only other option that most rural families are even aware of is the use of conventional building materials and construction techniques. In most cases they are not familiar with improved indigenous building materials which would enable them to significantly improve the environmental quality of their houses at an affordable price.

Since most rural families cannot afford to improve the quality of their housing through the use of conventional building materials and because they are not aware of the available alternatives, they continue to rely on traditional materials and hence, the quality of rural housing remains low. In fact, a United Nations publication noted that in 1975 as many as 7 out of 10 homes in the rural areas of developing countries were so unsuitable for human habitation that they required replacement or major alteration.[10] In Kenya specifically, the 1979-83 National Development Plan estimated that 625,000 rural houses were to be replaced during the plan period because they were beyond repair.[11] In summary, the housing problem in the rural areas of most developing countries is predominantly characterized by low quality.

Summary of the Problem

Generally then, one can say that it is the high cost of conventional housing in conjunction with limited use of appropriate alternatives that limits the degree to which people in urban and rural areas can increase the quantity and quality of their housing. A breakdown of conventional house-building cost by elements of cost shows that materials account for 50 to 70 per cent of the total, labour accounts for 30 to 50 per cent, and overhead represents 10 to 20 per cent. This breakdown confirms that, in the long run, the most important factor influencing total building costs is building materials.[12] Figures for the cost of conventional housing in Kenya reflect those presented above for worldwide housing costs. In fact, the Construction Cost Index shows that materials account for 59 per cent of the total, labour accounts for 23 per cent, and overhead represents 18 per cent.[13]

In terms of the cost of labour, a survey conducted in 69 less developed countries showed that self-help methods could also reduce the total cost by an estimated average of 33 per cent; and where families participated in the production of building materials for their homes, a reduction of up to 70 per cent could be obtained.[14] These figures and those presented above showing that it is the cost of building materials and labour which account for 82% of the total cost of a conventional housing unit in Kenya seem to indicate that the total cost of housing can be decreased significantly by decreasing the cost of building materials and labour.

Government Response to the Problem

With respect to decreasing the cost of building materials and the cost of labour in the house construction process, the 1984-88 National Development Plan indicates that the Government of Kenya has formulated several housing policies and objectives which address themselves directly to the two factors mentioned above. These include the following: (1) to formulate and adopt realistic and performance oriented building standards, especially in the area of low-cost housing; (2) to promote self-help in housing construction both in urban and rural areas so as to increase housing stock at a reduced construction cost; and (3) to intensify research on and use of local building materials and construction techniques.[15]

With respect to the first objective, the Government commissioned the preparation of a major study which reviewed existing building by-laws and regulations and made recommendations promoting the use of local building materials in Kenya's urban areas. The recommendations from the study have been incorporated in a new Sessional Paper on Housing which will be debated in Parliament this year.

With respect to the second and third objectives the Housing Research and Development Unit (HRDU) at the University of Nairobi is currently investigating the degree to which the use of low-cost local materials (i.e. stabilized soil-cement blocks and corrugated sisal-cement sheets) and construction techniques and local community participation can reduce the costs of house construction. These efforts seem to indicate that the Government of Kenya is committed to formulating a housing policy which will make housing more affordable to a greater percentage of the people in Kenya by offering them alternatives to conventional house construction.

HRDU has demonstrated the use of stabilized soil-cement blocks, corrugated sisal-cement roofing sheets, and local community participation in the construction of a health clinic in Nairobi and ten teachers' houses in Hakati and Mbita constituencies of Western Kenya. The site selected for the urban-based demonstration of the technology is located at Kabiro village which is within the Kawangware area of Nairobi and is approximately 10 kilometers west of the city center. Its location near the headquarters of the Housing Research and Development Unit made it possible for HRDU staff to regularly visit the site and monitor progress.

The purpose of the project was to demonstrate that the people of Kabiro, with minimum technical assistance from HRDU, could produce stabilized soil-cement blocks and sisal-cement roofing sheets on a self-help basis and then use these materials to construct a health clinic which could be used by members of the local community. The completed structure not only demonstrates a high quality of construction, but also indicates that the cost of construction can be reduced to approximately half by using locally produced building materials and local labour.

The sites selected for the rural-based demonstration of the technology are located at five different primary schools in Hakati and Mbita divisions of Western Kenya. At each of the sites two housing units were built with the same materials and construction techniques as those used at Kabiro. The purpose of the project was to transfer appropriate low-cost housing construction technology to rural communities by building demonstration housing units for teachers of government-assisted primary schools in these areas. A second purpose was to establish some means (in this case, one housing co-operative in each division) through which the technology transferred to the local communities could be further replicated by them in the future.

As in the case of Kabiro, this project addressed itself to the two factors which account for 82% of the total cost of a house. Through the use of improved indigenous building materials and community participation in the construction process, the project intended to build housing units at a cost of Kshs.48,000 each, a cost which was 50% lower than the cost of a similar house built with conventional building materials and techniques.

Hypothesis

The basic hypothesis of this study is that the use of improved indigenous building materials and construction techniques (i.e. appropriate technology) and local community participation in the construction process can significantly lower housing costs and thus contribute to the provision of housing which a larger percentage of the people in Kenya can afford.

This hypothesis has been formulated on the basis of the following assumptions:

(i) The cost of building materials and the cost of labor account for nearly 82% of the total cost of a conventional housing unit.

(ii) The high cost of conventional housing in conjunction with the limited use of appropriate alternatives limits the degree to which the housing problem in Kenya's urban and rural areas can be alleviated.

(iii) The costs of housing can be reduced significantly by decreasing the cost of the building materials and the cost of labor associated with the house construction process.

This hypothesis will be tested through an evaluation of a rural-based demonstration housing project in Hakati and Mbita divisions of Western Kenya, also known as the Improved Rural Technology (IRT) project.

Definitions of Terms

In this study several terms have been used in a way which may differ slightly from the more conventional meaning of the terms. For the sake of clarity these terms are defined below.

Whenever the term "appropriate technology" or "appropriate technologies" is used, it refers to the improved indigenous building materials, i.e. stabilized soil-cement blocks and sisal-cement roofing sheets, and construction techniques which were used in the construction of the houses included in the IRT project.

For the purpose of this study "community participation" refers to the involvement of the people in Hakati and Mbita constituencies in the planning, implementation, and post-implementation phases of the IRT project. This definition also includes the working relationship of the local people with the assisting agencies (i.e. the United States Agency for International Development and the Housing Research and Development Unit.)

Whenever the term "conventional building materials" is used, it refers to building materials which comply with the provisions of the Grade I by-laws of the Kenya Building Code. This term is best defined by giving examples of building materials which comply with these by-laws. For wall construction,the following materials comply: bricks or blocks composed of burnt clay, stone, concrete or sandlime. For roof construction, materials such as tiles of burnt clay or concrete, sheets of asbestos-cement, and corrugated sheets of galvanized steel comply with the provisions. However, stabilized soil-cement blocks and sisal-cement roofing sheets do not comply with the provisions of the Grade I by-laws, and for the purposes of this study are not considered to be conventional building materials.

The term "conventional housing" or "conventional housing unit" refers to the minimum standard accepted by Government. It has two rooms with kitchen, toilet, and shower; is built with conventional building materials as defined above; and has a minimum floor area of approximately 38.5 square meters.

Objectives of the Study

The general purpose of this study is to examine the degree to which appropriate technologies and local community participation can help to lower the costs of house construction. The general purpose of the study can be more specifically defined by the following objectives:

(i) to examine the appropriateness of the building materials and construction techniques which were used in the IRT project.

(ii) to examine the role of local community participation in the IRT project cycle.

(iii) to suggest how appropriate technologies and local community participation can be further utilized by housing co-operatives in Hakati and Mbita to build more teachers' houses.

Scope of the Study

The focus of this study is on the degree to which appropriate technologies and local community participation can lower housing costs. These two factors are examined in light of the technologies and participation process which were demonstrated in the IRT project.

Since the total cost of the project was dependent on many factors such as the speed of project implementation, the quality of the houses, and the original project objectives; the role that appropriate technologies and community participation played in lowering the cost of house construction is evaluated in terms of these factors.

But prior to the evaluation, critical baseline information on the project setting and the project description is presented. The project setting includes information on such things as the problem which gave rise to the project and a description of the beneficiaries, their society and their environment prior to the project. The project description includes information on the original project purpose, objectives, and strategies for implementation.

This information then forms the basis for evaluating the effectiveness and efficiency of the project. The first part of the evaluation examines the project's effectiveness, that is, the degree to which the project achieved its planned objectives. The second part of the evaluation examines the efficiency with which the project was implemented, that is, the degree to which the project succeeded in maximizing its beneficial results at the least cost. In evaluating the efficiency of project implementation, special emphasis is placed on the role played by appropriate technologies and local community participation.

Lessons learned from the evaluation of the project's effectiveness and efficiency in conjunction with findings from the literature review, especially concerning factors that have contributed to the successful implementation of other low-cost housing projects, then serve as a basis for suggesting how stabilized soil-cement blocks, sisal-cement roofing materials, and local community participation can be further utilized by the housing co-operatives to build more teachers' houses in Hakati and Mbita.

Research Methodology

The method of research used in this study to examine the validity of the hypothesis consisted of two phases: data collection and data analysis and interpretation.

In the first phase data was collected from both secondary and primary sources. Secondary data was gathered through the examination of existing publications about the IRT project, appropriate technology, community participation, evaluation methodologies, housing policies, housing standards, the building materials industry, and other related topics.

Primary data was collected through personal observations in the field and through personal interviews with local individuals in Hakati and Mbita constituencies who were directly involved in the project and with individuals in Nairobi who were involved in the project in one way or another. Field interviews were carried out during two separate visits to the 5 project sites in October and December of 1985. Questionnaires prepared prior to the site visits were administered to locally-based contact officials of the two housing co-operatives, the foremen at each of the sites, and some of the primary school teachers who were living in the demonstration units. By May of 1986,7 of the 10 houses had been occupied. Of the 10 families who were living in the houses 5 were interviewed by means of a mail questionnaire which was sent to the families in May of 1986. Additional information was collected through informal interviews with members of the local community who were involved in the production and use of soil-cement blocks and sisal-cement roofing sheets.

In Nairobi, information was collected through interviews with staff at USAID, staff at HRDU including the two field supervisors who were involved in the project, and other organizations interested in the use of soil-cement blocks and sisal-cement sheets such as Action Aid and the Institute of Cultural Affairs. Visits were also made to other projects in Nairobi where these improved indigenous building materials have been used.

In the second phase the data collected from primary and secondary sources was analysed through simple techniques involving the use of a calculator. Data from both secondary and primary sources was then interpreted in light of several objectively verifiable indicators of project effectiveness and efficiency. In fact, the evaluation methodology used in this study was adapted from methodologies used by USAID and the World Bank in evaluating housing projects financed by them. In evaluating project effectiveness the following indicators were considered: number of housing units completed, cost of each housing unit, time required for project completion, employment and income generation, accessibility of the houses to the target population, and replication activities which had already been carried out in the study area. The efficiency of project implementation was evaluated in light of the following indicators: speed of project implementation, cost of building materials and labor, quality of the houses, and potential replicability of the project.

Limitations

The major limitation was that only two of the ten teachers' houses were actually occupied during the visits to the site in October and December of 1985. This limited the degree to which information could be collected on the reaction of the tenants to various characteristics of the IRT housing units. However, in May of 1986 it was possible to obtain some of this information from mail questionnaires which were filled out and returned by five of the ten tenants who were living in the houses at that time.

Second, since the Peace Corps volunteer who was supervising the IRT project during the first 16 months when the speed of implementation was so slow had to return to the United States in June of 1984, it was not possible to get his personal view about the reasons for the project's slow progress. However, most of this information was collected through discussions with people at USAID and HRDU.

Third, the remote location of the study area and its long distance from Nairobi made it difficult to travel to the project sites to collect more specific data on some aspects of the study, especially concerning the most recent plans of the housing co-operatives to replicate the technology.

Fourth, since the financial records kept by the project supervisor during the first 16 months of the project were not complete, the figures quoted in Chapter 4 for the actual expenditure on building materials and labor are not exact. However, since 81% of the total expenditure on materials and labor was incurred after the first 16 months when accurate monthly records were being kept by the project supervisors from HRDU, the figures quoted should represent relatively close approximations of the exact values.

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14. United Nations, <u>World Housing Survey 1974</u>, p.104.

15. Republic of Kenya, <u>1984-88 National Development Plan</u>, p.164.

Introduction

The purpose of this chapter is to review the pertinent literature about the two major aspects of this study, appropriate technology and community participation, and the methods for evaluating their role in the process of project implementation. Given the basic hypothesis of this study as presented in the last chapter and its emphasis on the role of appropriate technology and community participation in lowering the cost of housing, the first part of this chapter examines these two concepts in more detail. In terms of appropriate technology special emphasis is placed on the use of earth and sisal-cement as building materials for house construction.

Since the hypothesis is to be tested through an evaluation of the IRT project, the second part of this chapter assesses several methods of evaluating the implementation of housing projects. Given the significant role that USAID and the World Bank have played in the provision of shelter for the low-income groups, especially during the last ten years, special emphasis is given to the evaluation methodologies developed and used by these international aid agencies to evaluate housing projects financed by them.

Appropriate Technology

The use of appropriate technology constitutes a relatively new approach to the process of development. During the last two decades many books have been written about appropriate technology by authors such as Schumacher, Ghai, and Riedijk. Many experimental projects utilizing appropriate technologies have been promoted and built by international and national organizations, bilateral aid agencies, non-governmental organizations, and research centers. These experimental projects have demonstrated a wide range of technical applications in areas such as farming, irrigation, water supply, sanitation, and housing.

But how did the concept of appropriate technology originate and why is it starting to be seen by many authors as a more appropriate approach to satisfying the needs of the developing world? Riedijk argues that the industrial revolution brought about mass production and a reliance on capital intensive technologies. It could have brought about production for the masses; but it has resulted in enormous inequities, especially between the industrial countries and the developing countries.[1]

These capital intensive technologies resulting from technological developments since the industrial revolution have simply been transferred to developing countries without modification. This has been the most common approach employed by industrialised countries to help the developing countries to better themselves. But in most cases the developing countries do not yet have the financial or human resources needed to maintain such technologies. For example, this approach has resulted in the introduction of diesel-driven water pumps to areas where diesel fuel is not readily available, tractors and combine harvesters to countries where subsistence agriculture is still practiced by 80 to 90% of the people, and expensive water borne sanitation systems to countries where the per capita income is less than $350 per year. The failure of this approach to address itself to the economic, social, and cultural realities of developing nations has caused many authors to support the concept of appropriate technology.

Riedijk has defined appropriate technology as follows:

> Appropriate technology is the application of all (technological) abilities based on (scientific) knowledge for the satisfaction of the (fundamental) needs of a specific group of people in its own cultural and natural environment using appropriate

> management and organization methods enabling the group itself to start, maintain and continue the production of their goods and services.[2]

The important elements in this definition can be briefly summarized by the following statement: the use of appropriate technology by local people to meet their own basic needs for food, clothing, and shelter.

The following statement from a report prepared at an Ad Hoc Expert Group Meeting on the Development of the Indigenous Construction Sector relates the idea of appropriate technology to the building materials and construction industries:

> The more sophisticated of the technologies used in industrialized countries are generally not suitable to the conditions which prevail in developing countries. A revised approach is necessary to select the technologies that are appropriate in terms not only of the economic needs of developing countries but also of their social and cultural circumstances. It is necessary to focus on the development of indigenous building materials and construction industries and to emphasize construction techniques that favour the use of local resources.[3]

This statement emphasizes the need for building technologies to be appropriate to the local situation in any particular country.

More specifically, Dr. Arcot Ramachandran argues that there is a need for the development of appropriate building technologies which will facilitate the construction of low-cost housing. In fact, he emphasizes the need to develop locally produced construction materials and components which will reduce the dependence of developing countries on imported construction materials. In most African countries, building materials imports account for approximately 50 per cent of the total cost of construction.[4]

In terms of appropriate housing technologies, P. Huybers suggests that it is not realistic to think of one, generally applicable solution, suitable to make an end to all problems existing in the field of world housing need, because the local situation and the available means show a wide-spread diversity from place to place. He suggests that each solution must fulfill a number of general criteria which define its appropriate character. To be appropriate it should: (1) take into account the existing climatical circumstances, (2) use locally available materials, (3) incorporate indigenous techniques and craftsmanship, (4) apply indigenous building forms, (5) let the existing need be specified by the local inhabitants themselves, involving them in every stage of the decision making process and especially in the execution of the project, (6) apply materials with a low energy consumption, and (7) avoid the use of machines for production, transport and lifting gear.[5]

Anil Agarwal contributes to the validity of the preceding definition and criteria by suggesting that a building material which will meet the housing needs of the poor and promote the self-help construction process must have three characteristics. It must be cheap, readily available, and easy to use. He notes that traditional building materials, such as mud, timber, thatch and stone, have been used by people for centuries, and meet all three of these criteria.[6]

Riedijk, Huybers, and Agarwal all agree that the use of low-cost local materials (i.e. appropriate technology) and local participation in the construction process are critical elements of an appropriate solution to one of man's basic problems - the need for shelter.

As mentioned above, appropriateness of building materials and construction techniques can often be defined in terms of what is available at specific locations. In the last few years, a recurrent theme of the statements made by international and national institutions about the improvement of human settlements has been the need for research on appropriate construction technologies. In this very broad field of investigation, "earth" has been one of the most discussed building materials.[7] Research institutions in Kenya such as the Housing Research and Development Unit (HRDU) at the University of Nairobi are also examining the potential for the use of stabilized earth as a building material for wall construction.

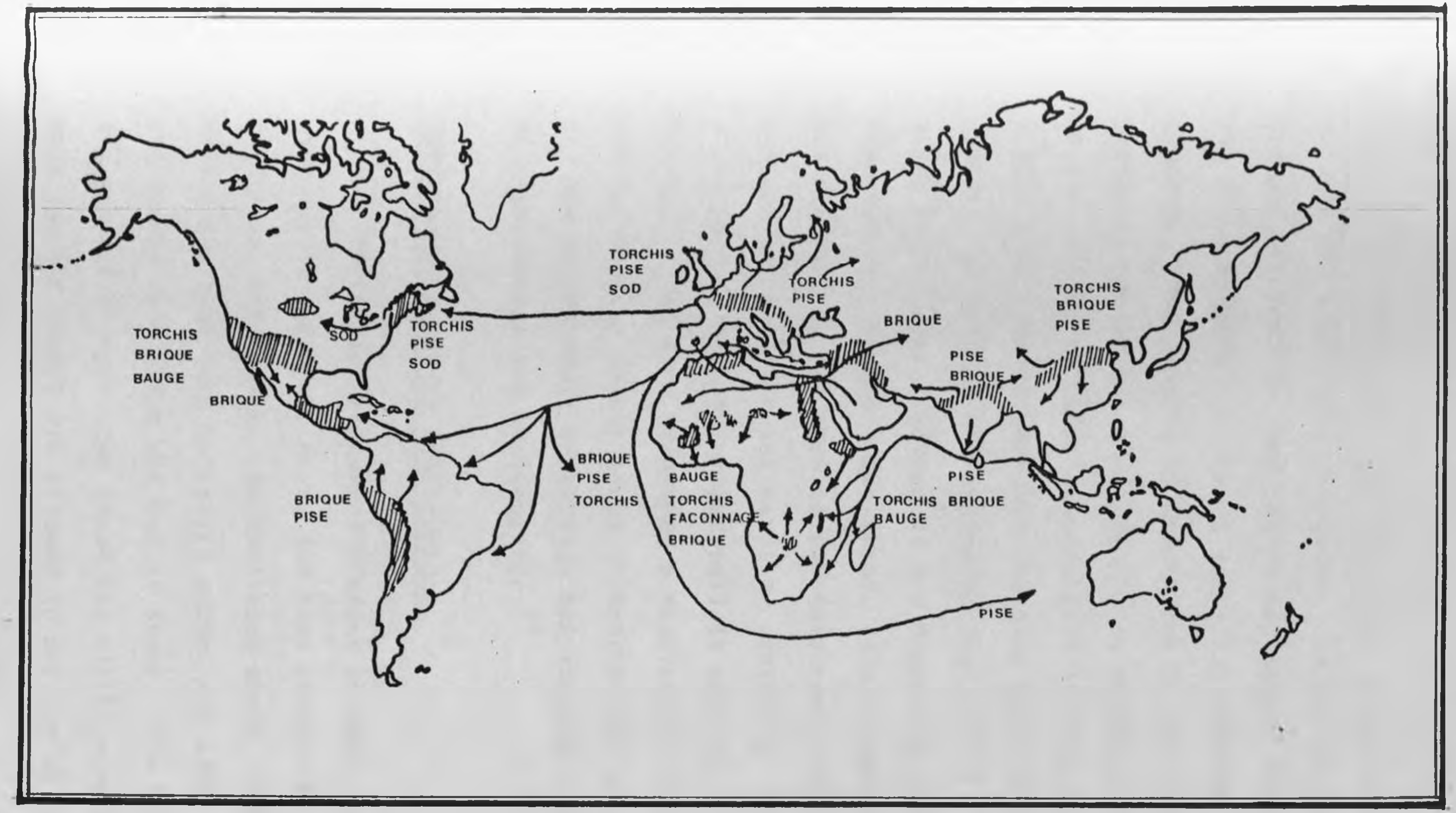
In addition to HRDU's research on earth construction technologies, HRDU, the Appropriate Technology Center at Kenyatta University, and the Village Technology Unit at the Karen Center for Research and Training, and other organizations in Kenya are also experimenting with the use of corrugated sisal-cement sheets as an alternative roofing material. In terms of appropriate construction technologies, it is these two which have dominated Kenyan research during the last few years. It was as a result of this research that the decision was made to use soil-cement blocks and sisal-cement roofing sheets in the construction of the IRT housing units. Since this study examines the role of these two building materials in lowering the cost of house construction, the remainder of this section on appropriate technology will present a more detailed discussion of earth construction technologies and the use of sisal-cement sheets as a roofing material.

Earth Construction Technology

Historical Development

Earth has been used as a building material for more than 10,000 years in the Middle-East and for more than 8000 years in Egypt and in some parts of Asia. Since these early dates it has been used in the construction of many types of buildings, from elementary shelters to magnificent palaces. And some of these buildings (e.g. a tenth century Coptic church in Aswan, Egypt) are still standing today. In different parts of the world the use of earth has been given different names depending on the various techniques used. Map 2.1 shows the widespread use of earth as a building material from east to west and from north to south.[8]

What is shown on the map is still valid for more than 80% of the places indicated. In fact, more than one third of the people in the world are still living in buildings made partially or entirely out of dried, unbaked earth. In some regions the percentage is even higher. For example, in rural areas in Zambia, Kenya, Turkey, and Egypt more than 50% of the population is sheltered in mud houses. And in India it is estimated that 66 million houses have used mud for construction in one form or another.[9]



MAP 2.1: USE OF EARTH IN BUILDING AROUND THE WORLD

Source: Houben, 1984.

But earth construction today is not limited to only the developing countries. In France, Belgium, Germany, Australia,. and the United States buildings are being erected totally or partially with earth products. The example of New Mexico in the United States is one of the most convincing demonstrations of the ability of earth construction techniques to evolve over time to meet the changing needs of home owners. In 1980 it was estimated that 3 to 4 million adobe bricks were produced in New Mexico by individual home owners. However, the trend, even on smaller building sites, has been to purchase ready-made bricks, produced on a commercial basis at centrally located adobe yards, where the right soil is available.[10] New Mexico has even developed a regulatory code for mud buildings - mainly adobe (sun-dried mud bricks), and New Mexico State University has started a course on adobe design and construction.[11]

Techniques for Earth Construction

Throughout history different societies have used mud in different ways, and have given the technique many names. As mentioned above, in New Mexico the technique is called adobe, and adobe blocks are formed by placing wet mud in forms. The forms are removed a short time after the blocks have been made and the blocks are allowed to dry for at least one month before use.[12]

Cob is the English term for mud mixed with chopped straw, lime and sometimes a little aggregate. The moistened material is molded into balls about the size of a person's head and then piled up in horizontal layers. Walls of cob buildings were kept dry by a generous roof overhang usually made of thatch, and a waterproof plinth was made to protect the walls from ground dampness.[13]

Wattle and daub is a technique commonly used in the rural areas in Kenya and many other African countries. The framework of posts and poles is constructed and then reeds or branches are woven in between to form the base for a moist mud plaster which is then applied to both sides. Another method is to make two frames standing a short distance apart and to fill the space in between with mud.[14]

In Brazil, Zimbabwe, France, and some parts of Kenya another technique known as pise or rammed earth is used. In this technique continuous walls are formed by ramming moist soil between sturdy wooden shutterings. When one section of wall is complete, the form is moved to the side or upwards and the process is repeated.[15]

Most recently, the use of pressed blocks has been adopted in many parts of the world, and a number of soil block presses have been developed for the purpose of compacting these blocks. In some cases the blocks are stabilized by mixing cement, lime or pozzolans in with the mud. By stabilizing the blocks with these admixtures; they become stronger, more durable, and more resistant to moisture absorption. Lime-stabilized soil is not as strong or water-resistant as cement-stabilized soil but it is certainly an improvement over plain soil.[16] Stabilization is normally required in climates that have more than 25 to 30 inches of rainfall per year.[17]

Advantages of Earth

This brief description gives an idea of the different earth construction techniques which can be used. It is difficult within the scope of this study to highlight the advantages and disadvantages of each technique. However, Agarwal does present a general summary of some of the economic and technical advantages and disadvantages of earth as a construction material. He states that earth, as a building material, has the following advantages: (1) it is cheap, and in most parts of the world is readily available; (2) it provides excellent heat insulation, so inside, a mud building is cooler in summer and hotter in winter than a building made with steel and concrete; and (3) it is strong in compression and thus is a good material for wall construction.[18]

Disadvantages of Earth

But he notes that earth also has some serious disadvantages: (1) it is eroded easily by water which makes its use difficult in areas with high rainfall; (2) it has a low tensile strength which means mud roofs are difficult to make; (3) it is susceptible to mechanical damage from rodents; and (4) it does not grip wood properly so gaps often develop around wooden doors and windows in mud walls.[19]

Agarwal notes that these disadvantages can often be overcome through suitable improvements in design and technology. First, architecture can be used to enhance the advantages of mud. Narrow streets and closely packed houses can produce a cool environment in a hot region, and overhanging roofs can reduce erosion caused by rain. Second, structural techniques (e.g. the use of rammed earth techniques) have been used to enhance the characteristics of mud. Third, soil stabilization, as mentioned above, improves mud's strength and resistance to water.[20]

However, one of the most significant

disadvantages of earth is that many people consider it to be an inferior building material, and hence resist the idea of using it in house construction. Although the 1984-88 National Development Plan supports research on and the use of local building materials and construction techniques; in practice, the initial response of both government officials and local authorities has been to reject the use of soil-cement blocks and sisal-cement sheets in house construction, especially in Kenya's urban areas.

For example, from August of 1983 to October of 1985 Action Aid-Kenya, a non-governmental organization assisting rural communities, helped the people of Mado Gashi to construct a primary school. Although the people initially resisted the idea of using soil-cement blocks to build the walls of the classrooms, dining hall, teachers' houses, and pit latrines; Action Aid officials demonstrated to the people the potential of using earth as a durable material. However, every time the District Works officer from the Ministry of Works, Housing, and Physical Planning visited the project, he ordered the people to stop construction because he found the soil-cement blocks to be unacceptable. But since he was not present at the site daily to enforce his directive, the people continued to build the school.

In Nairobi, the local authorities could not approve the use of soil-cement blocks and sisal-cement sheets in the construction of a health clinic in Kabiro Village. Consequently, the health clinic was declared to be a "demonstration structure". In Nyahururu, supporters of the technology from Action Aid, J.P.M. Parry and Associates, and the Peace Corps have spent the last three years trying to persuade the local authorities and officials from the National Housing Corporation to use the technology in the construction of a 50-unit municipal housing scheme. During the first part of 1986 both organizations officially approved the idea, and since then, the production of soil-cement blocks and sisal-cement pantiles has begun.

This resistance from governemnt agencies and local authorities has persisted despite the fact that soil-cement blocks and sisal-cement roofing sheets satisfy all requirements of the Grade II By-laws and the performance requirements of the Grade I By-laws. Marja C. Hoek-Smit argues that local authorities do not have the necessary staff to investigate the use of alternative building materials. Consequently, they require the use of building materials which they know from experience will create no problems. Therefore, the Grade I By-laws are often applied stringently and consequently, the use of soil-cement blocks and sisal-cement sheets is prohibited. Even where permission to apply Grade II By-laws is obtained, the local authorities often impose higher standards than required by these By-laws.

Machines for Block Production

Soil stabilized with cement or lime can be compacted by any one of a variety of manually, hydraulically, or mechanically operated machines. In order for one of these machines to produce an adequately stabilized soil block it must be capable of exerting a pressure on the block surface of at least 1 to 2 MN/m^2. Table 2.1 provides a listing of several block pressing machines and their characteristics as compared by the Association for the Development of Traditional African Urbanism and Architecture (ADAUA).[21]

Type of Block-pressing Machine	Mode of Operation	Country of Origin	Weight (kg)	Production per day (blocks)	Labor Force required (number of men)	Block Size (mm)	Pressure Exerted (MN/m^2)
Cinva-Ram	manual	Colombia Canada USA England	63	300	5	290x140x 90	.7-1.7
Tek-Block	manual	Ghana	97	300	5	290x216x 140	1.2-2.4
Brepak	hydraulic	England	172	300	5	290x140x 100	3.0-10.0

TABLE 2.1: CHARACTERISTICS OF BLOCK-PRESSING MACHINES

Source: ADAUA, 1977.

The most well-known of these machines are the Cinva-Ram and the Tek Block which are both manually operated machines. The Cinva-Ram was initially developed as a tool for small individual or mutual self-help programs. It is still the lightest machine available and has been copied and modified several thousand times in all parts of the world. Its cost in Kenya in 1985 was $250 US.[22] The Tek-Block press has been developed on the basis of the design for the Cinva-Ram. However, it is simpler to operate, produces larger blocks, has studier construction, and costs less - about $160 US in 1981.[23]

A third type of manually operated machine which has been used in Kenya since 1981 is the "Brepak" block press. It is simple to operate, but it does have a hydraulic component which enables it to compact the blocks to a greater degree than either the Cinva-Ram or the Tek-Block presses. However, the hydraulic component is also more difficult to repair when it breaks down. It produces blocks that are the same size as those produced by the Cinva-Ram, has the sturdiest construction of the three, but costs significantly more - about $1400 US in 1985.[24]

Small, manually operated machines like the three mentioned above are best suited for the following conditions: (1) where there are limited capital resources; (2) for projects in remote areas, or those that lack the necessary infrastructure; (3) where the building site is small; (4) in areas of low precipitation, where the resistance to water penetration does not need to be as high; (5) for small building projects with single-storeyed structures, for which the quality of soil blocks is of less importance; (6) in places where the potential for self-help inputs is high; and (7) where entrepreneurs, with a small capital base and a team of unskilled workers, produce soil blocks for the local market.[25] These are precisely the types of conditions found in most parts of Kenya.

High capacity machines are advantageous in areas where sufficient financial resources are available; in cases where high production rates are needed and there is a high demand over a long period; for projects that require the highest quality of soil blocks; in working environments with sufficient energy supply as well as maintenance and repair facilities; or in cases where labor is expensive or not easily available.[26] Such conditions might exist in a place like Nairobi if the coordinators of a large housing project decided to use soil-cement blocks to construct the walls of all the houses.

In view of the vast choice of soil block presses available (there are more than forty on the market today), Kiran Mukerji suggests that the following criteria be considered in selecting a press: (1) ancillary devices - does the soil block press incorporate all the functions required for block production, or does additional equipment (e.g. crushing machine, sieve, mixer, measuring scoop, etc.) have to be purchased?; (2) material quality - poorly compacted blocks are porous, absorb moisture easily, and thus require more maintenance; (3) block size - small sizes require a greater number of blocks per cubic meter than larger ones so the overall effort needed to produce small blocks is greater than that of making large ones; and (4) manual work - as the working day progresses, gradual exhaustion causes diminishing performance and lower quality blocks.[27]

When one considers that 1,600,000,000 people live in earth shelters or houses today, that in regions such as the southern part of the United States there is an increase in the production of earth construction materials on both a commercial and private basis, and that research has provided means by which the quality of earth products can be improved;

one can conclude that earth is still a pragmatic response to an increasing demand for better housing within the limits of scarce national resources and minimal individual means. In fact, it is perhaps the only way responsible national leaders will find the answer to substantially alleviating the shortage of housing in the next decades.

Sisal-cement as a Roofing Material

Earth construction technology may provide part of the answer to meeting the housing need in the coming years, especially as a wall construction material. However, as was noted earlier, the fact that earth has a low tensile strength and soaks up water easily makes it difficult to use it as a roofing material. Given this disadvantage, research institutions around the world, including those in Kenya, are examining the potential of using corrugated sisal-cement sheets as an alternative roofing material.

The roofing materials which have traditionally been used in East Africa, such as thatch, have a relatively short life. Improved materials such as corrugated galvanised iron or asbestos-cement sheeting are expensive, often require foreign exchange, and are sometimes hard to obtain. Although weaker, sisal fibers can be used to improve cement mortar in a similar manner to asbestos, and the resulting material can be used for roofing sheets as long as suitable restrictions on span are maintained.[28]

Spread of the Technology Worldwide

Sisal-cement technology was developed in Kenya, Tanzania, the United Kingdom and Sweden in the 1970s and has since been tried out in at least 16 developing countries including Fiji, Indonesia, Sri Lanka, Malawi, Bangladesh, Honduras, Gambia, Sudan, Egypt, Colombia, Dominican Republic, Zimbabwe, El Salvador, Tanzania, Zambia, and Kenya. The spread of the technology to so many different countries is largely a result of the work being done by Intermediate Technology Industrial Services (ITIS) and J.P.M. Parry and Associates.[29]

In the production of sisal-cement roofing sheets two different techniques are currently being supported by various proponents of the technology. Advocates of the short-fiber technique (i.e. the Intermediate Technology Building Materials Workshop in Britain and institutions in Malawi and Zimbabwe) recommend that a proportion of short, randomly-oriented fibers be added to the cement mortar to achieve the following effects:

(i) Plasticity is increased, thus allowing moulding without cracking.

(ii) Micro-cracking during hardening is controlled, thus reducing permeability.

(iii) Impact resistance is increased.

(iv) Bending strength to first cracking is slightly reduced but there is a reserve of strength after.cracking.

The optimum length of the fibers has been found to be about 10 to 15 mm.[30]

In addition to adding short fibers to the sand-cement mortar, advocates of the long-fiber technique (i.e. the Building Research Establishment in Britain and institutions in Kenya, Tanzania, and Sweden) also include mats of long fibers in the mixture. The addition of long fibers increases bending strength to first cracking, post-crack load bearing capacity, impact resistance, and vibration resistance. However, the addition of long fibers to the mixture is a slightly more complicated and time-consuming production process.[31] In the IRT project the long-fiber process was used, and a more complete description of the production process used in that project is presented in the next chapter.

Kenyan Experience

The long-fiber technique used in the IRT project was first developed in the 1970s by Dr. D.G. Swift of Kenyatta University College and Professor R.B.L. Smith of the Civil Engineering Department at the University of Nairobi. Since then, the technique has been successfully tried and tested by several organizations including the Village Technology Unit at the Karen Center for Research and Training, the Housing Research and Development Unit at the University of Nairobi, the Undugu Society of Kenya, and several others.[32] These organizations have used the sisal-cement sheets as a roofing material on many types of structures including houses, classrooms, a health clinic, and storage buildings. In some applications there have been serious quality control problems, but there have also been some very successful examples.

In addition to the work being done with sisal-cement sheets, J.P.M. Parry and Associates introduced the use of sisal-cement pantiles as a roofing material in 1984. The mixture of sisal fibers, cement, and sand used in the production of pantiles is similar to that used in the production of sisal-cement sheets by the short-fiber process. The sisal-cement pantiles are produced with the assistance of a vibrating screeding machine which is usually powered by a car battery. Currently, the machine can only be obtained from manufacturers in Britain, and it costs approximately Ksh. 16,000. However, HRDU and other organizations in Nairobi are currently working on a design for a hand-operated version of the machine which could be produced in Kenya for approximately Ksh.4000.

Action Aid-Kenya, a non-governmental organization which assists rural communities, has used the sisal-cement pantiles as a roofing material in several building projects. The organization has been quite satisfied with the performance and visual appearance of the pantiles and has helped groups of local people in Nairobi, Kibwezi, Webuye, and Kiboswa to set up small-scale industries for production of the tiles. It costs approximately Kshs. 35,000 for the structures and equipment required to set up a tile-making plant (Action Aid figures, 1985) like the ones mentioned above. At such a plant approximately 200 pantiles can be produced per day.

In January of 1986 the material cost to produce 13 pantiles, which is approximately one square meter of roofing, was about Kshs.30. This cost includes the depreciation of the structures and equipment, but it does not include the labor cost for producing 13 pantiles. This cost compares quite favorably with a cost of Kshs.63/20 for one square meter of 28 gauge corrugated galvanized iron. However, when the cost of structural timber for supporting these roofing materials is added to the material cost, the difference between the two is not as great. With the cost of structural timber added, the cost of one square meter of sisal-cement pantiles is Kshs. 74 while the cost of one square meter of 28 gauge galvanised iron is Kshs.95/87.

Advantages of Sisal-Cement

Sisal-cement sheets offer the following advantages when used as a roofing material: (1) they are about 50% cheaper than most of the alternative roofing materials (e.g. corrugated galvanized iron and asbestos-cement sheets) of equivalent quality; (2) they are locally made on site by previously unskilled local people, using simple tools and techniques; (3) they are produced from indigenous raw materials such as sand and sisal fibers, although the main ingredient, cement, may not be as readily available; (4) they have very high values of fire resistance, noise absorption, and heat insulation, all of which combine to give an excellent indoor environment without the need for a ceiling; and (5) they have an adequate factor of safety for wind loads, but not for the weight of people.[33]

Disadvantages of Sisal-cement

The major disadvantages associated with the use of sisal-cement sheets such as cracking, water leakage, and questions about durability and strength are directly related to the care with which the sheets are made, stored, and installed. If proper quality control is maintained, the sheets will perform well. Common production problems include high water content in the sand-cement-sisal mixture, poor compaction of the sheets in the mould, the failure to cut the edges properly, and inadequate curing of the sheets.[34]

Marketing of Sisal-cement Roofing Sheets

Given the low profit margin associated with the marketing of sisal-cement roofing sheets, Sakula suggests that a co-operative, self-help group, or travelling team have the best chance of success in producing and selling sisal-cement sheets in low-income rural areas. However, he also notes that a more conventional commercial enterprise could be financially viable if the sheets are sold in urban or more affluent rural areas.[35] Finally, Sakula cautions that the use of sisal-cement sheets as a roofing material may not always be the most appropriate technology to use. Availability of cement, sisal, water, sand, timber, cash, time, and incentive must always be considered in relation to any particular location.[36]

Summary

Appropriate Technology is seen by many as being a more appropriate approach to satisfying the needs of the developing world. Since appropriate technology relies predominantly on natural and human resources that are locally available in developing nations, it more realistically addresses itself to the economic, social, and cultural needs of the people in these countries. The concept can be applied to a wide range of technical applications in areas such as farming, water supply, and housing.

In the area of housing, appropriateness is often defined in terms of the types of building materials and construction techniques used in house construction. Research institutions in Kenya such as HRDU have been examining the appropriateness of two building materials in particular, stabilized soil-cement blocks and sisal-cement roofing sheets. Because the production of these two building materials relies primarily on inexpensive materials like earth and sisal that are locally available in most parts of Kenya, it is expected that the increased use of these low-cost materials could significantly decrease the cost of house construction and thus enable the public and private sectors to build more houses with the same amount of money. It was in light of this expectation that the decision was made to further utilize soil-cement blocks and sisal-cement sheets in the construction of the IRT housing units.

Community Participation

As was mentioned in the previous section on appropriate technology; Riedijk, Huybers, and Agarwal suggest that community participation in conjunction with appropriate technology are key considerations in the search for a solution that will help meet the housing needs of the poor. At an international level, the need for community participation in the development of human settlements was highlighted at the United Nations Conference on Human Settlements held at Vancouver in 1976. In fact, recommendation E.1. states: "Public participation should be an indispensable element in human settlements, especially in planning strategies and in their formulation, implementation and management; it should influence all levels of government in the decision-making process to further the political, social and economic growth of human settlements.[37]

At a national level, the Kenyan National Development Plan for 1984-88 stresses the need to promote self-help in housing construction both in urban and rural areas so as to increase the housing stock at a reduced construction cost. The Government has proposed several housing strategies which will attempt to involve members of the local community in providing housing for themselves. These strategies include site-and-service programs, settlement upgrading, and co-operative housing.[38]

Definition of Community Participation

Community participation in the execution of low-income housing projects can be defined as the voluntary and democratic involvement of a local community in carrying out project activities such as establishing priorities, preparing plans, making decisions, implementing plans, and providing finance.[39] It should be emphasized that low-income housing projects are not carried out in isolation but are elements of national social and economic development for which government is primarily responsible. Consequently, community participation implies that the community "takes part in" the execution of a project together with the project staff; it does not mean that the community should "take over" a project.[40]

Importance of Community Participation

The idea of involving beneficiaries in the execution of low-income housing projects was a direct response to an increasing demand for shelter and the corresponding inability of the public and private sectors to meet the demand because of the high capital costs involved in providing housing. It was expected that if beneficiaries assumed part of the labor component in the implementation of the housing scheme, a considerable reduction in the costs of housing units would be achieved.[41] Thus, more housing units could be built for the same amount of money. Community participation was first advanced with the hope that it would lower the capital costs of housing.

In addition to lowering the costs of housing, Yap Kioe Sheng argues that community participation should be incorporated in the execution of the project for three additional reasons. First, participation is an end in itself. People have the right and duty to participate in the execution of projects which significantly affect their lives. Second, participation is a means by which project results can be improved. If people participate in the execution of projects by contributing what they can; more people can benefit, implementation is facilitated, and the outcome responds better to the needs and priorities of the beneficiaries. And third, participation is a self-generating activity which prompts people to actively participate in other areas of life. Participation creates a spirit of self-reliance and co-operation in communities which enables people to identify and deal with their problems.[42]

Constraints to Community Participation

Although the potential of community participation to lower housing costs and increase community cohesiveness was great; in reality, the initial attempts to incorporate participation in the execution of low-cost housing schemes proved to be less successful than anticipated. And now, thirty years later, several contraints still limit the degree to which the initiative and resources of beneficiaries are utilized. The major ones include an authoritarian attitude on the part of project staff members who think they know best, lack of skills on the part of both project staff and beneficiaries, lack of time for some beneficiaries to participate in house construction because of their involvement in formal or informal employment activities, and the existence of standards, codes, and regulations which are unsuitable to the implementation of community participation in low-income housing projects.[43] Such codes tend to be insensitive to indigenous technologies and building techniques which might make efficient use of locally available materials and labor.

Modes of Participation in Decision-Making

A number of modes exist through which the local people can join the project staff (e.g. planners, administrators, and managers) in the decision-making process. The first mode of participation is one in which the beneficiaries have no formal voice in planning and decision-making. This does not mean that the people will not shape their own living environment. They will, but it may not be in harmony with what the planner expected.[44]

A second mode is one in which the beneficiaries assume an advisory role in the decision-making process. They are consulted about the plans, but the project staff has the authority to make final decisions. The degree to which the people are consulted depends on when they are first involved in the project. If it is near the end of the project; the main decisions have already been made, and consultation only means extending information and asking beneficiaries to endorse the plans or to suggest small revisions. If it is at the beginning, the planners may prepare the plans together with the community, giving them a significant share in the decision-making process.[45]

The third mode of participation (which can occur in combination with the second one) is one in which there is representation of beneficiaries on the decision-making body.[46] This mode maximizes the degree to which beneficiaries are able to influence the content of the plan.

Community Participation in the Project Cycle

The decision-making process is a continuous part of the entire project cycle. According to conference participants who attended the Sixth Annual Conference on Monitoring and Evaluation of Shelter Programs for the Urban Poor held at Ottawa in 1979, community participation is important in three stages of the project cycle. The first of these is the project design stage. Projects must reflect the basic needs of beneficiaries if they are to be successful.[47] The best way to ensure that projects meet the needs of beneficiaries is to involve them in the project design stage when detailed objectives are formulated.

In the second stage (i.e. project implementation) community participation is especially important in order for implementation to progress smoothly.[48] Participation in project implementation can be organized in several different ways: (1) mutual help in which families work together in groups, usually with supervision from the project management; (2) self-help construction in which the family hires a contractor to build the house; (3) self-help construction in which the family hires and supervises individual laborers; and (4) self-help construction in which the family uses its own labor to build the house.[49] In the Dandora Sites-and-Services Project in Nairobi all four methods were utilized by the allottees. Table 2.2 presents a comparison of three of the methods mentioned above. In the comparison, the advantages and disadvantages of the three methods are identified with respect to four parameters: time, money, skills, and control.

Participation in implementation in the form of individual or mutual self-help has a much longer history than participation in project design. The idea of self-help construction through methods similar to those mentioned above was first introduced in the 1950s as a way of reducing the capital cost of house construction. However, the self-help method of construction has not always been successful in

	Individual self-help	Mutual self-help	Contractor
Time	It takes a long time for the allottee to complete his house if he can only work in his spare time.	Although faster per housing unit than if built by individual self-help, it still takes a long time to complete all houses for the group.	The house can be built quickly.
Money	The cost of the house is lower than for a completed house, as the allottee provides the labour.	The cost of the house is lower than for an individually built house, as the group provides the labour, and building materials can be purchased in bulk.	The house is more expensive than a self-built house, as the contractor also has to make a profit.
Skills	Unless he is a skilled labourer or receives an intensive training, the allottee will have difficulties meeting standards.	Unless the group includes some skilled labourers or receives an intensive training, it will face the same problems as the individual self-help builder.	The contractor provides the skilled labour, and the allottee can contribute unskilled labour, if necessary.
Control	The allottee is in full control of the construction process: he can build what, when and how he wants (within limits set by the project).	The group is in control of the construction process; this requires cohesiveness, management skills, conflict-solving abilities etc.	Unless the allottee has the capacity to supervise the construction work, the contractor controls the construction process.

TABLE 2.2: COMPARISON OF DIFFERENT METHODS OF HOUSE CONSTRUCTION
Source: UNCHS-HABITAT, 1984, p.22.

accomplishing the objective of reducing capital costs.

One problem is that families do not always have the appropriate technical skills or the manpower to build their own houses.[50] For example, the allottees of the Glen View Sites-and-Services Scheme in Harare are convinced that house construction is basically a skilled job and that, unless one is an experienced artisan, their contribution to the construction work should be limited to those activities requiring unskilled labor. In their opinion it is better to ask a skilled contractor to build a good house which meets the standards than to try to construct the house on a self-help basis and see it demolished afterwards.[51]

A second problem is that many low-income families cannot find the time to construct their houses.[52] For example, in Dandora 38% of the allottees hired contractors to build their houses for them since they (i.e. the allottees) had to be at work themselves during the day.[53] Given these two common problems, one can conclude that it is not the allottee's contribution in labor to the construction of the house that is important, but rather, his control over the construction process and his participation in the project design stage.

The third stage of the project cycle which requires community participation in order to be successful is the post-implementation stage. A well-organized and involved community will be likely to take responsibility for maintaining community facilities after the implementation phase. Without involvement, inhabitants of the project area may perceive infrastructure and buildings to belong to the government and not to themselves, and thus may assume that the government should maintain them.[54]

Requirements for Effective Community Participation

In order for community participation to be effective throughout the design, implementation, and post-implementation stages of a project it is suggested that eight requirements be considered. However, it is also noted that these requirements cannot be assembled as a fixed and rigid system, but rather, the implementation of projects differs so widely with respect to culture, legal situations, political aspects, size, finance, technology etc. that it is not likely that every project will address itself to each of the eight requirements.[55]

Felt Need

The first requirement is that there has to be an immediate need to initiate group action. In order to motivate the people to participate actively in the execution of projects, it is essential that projects meet the most urgently felt needs of the people and have some immediate impact on their living condition.[56] For example, in the IRT project the need identified by some members of the local community was to provide improved teachers' housing at primary schools in the study area.

Clear Concept of Target Groups

The second requirement is that there must be a clear concept of the target groups. The identification of target areas is a sensible first step for promoting self-help housing activities, whereas the determination of target groups within those areas is a second one. There are different ways of selecting a target group, and a general rule cannot be given since the selection depends on specific circumstances.[57] In some cases the selection may be made on the basis of specific criteria, as was the case in Dandora. In other cases the selected group may be composed of people who have similar characteristics. Such was the case in the IRT project where the selected target group consisted of primary school teachers.

Comprehensive Information Program

The third requirement is that there must be a comprehensive information program. After the target group has been defined, the next step is to inform the prospective participants of the relevant features of the proposed project and the conditions of their participation. The information provided should cover the following items: (1) aims and proceedings of the project; (2) the self-help character of the project; (3) the financial implications and property regulations; (4) the building technology and the building process; (5) structure of organization and administration of the project; (6) the role of possible external agents; and (7) the presentation and role description of personnel. Everyone involved in the project must be informed about the proposals in order to reduce future cases of misunderstanding the project's implications.[58]

In the IRT project, some local leaders never understood the purpose of the project and thus were not able to clearly explain the project objectives to the local people, especially concerning the provision of self-help labor and the ownership of the houses. The failure of local leaders to communicate clearly resulted in significant project delays.

Supportive Community Structure and Accepted Local Leader

The fourth and fifth requirements are closely related. The fourth is that there must be a supportive community structure, and the fifth is that a socially active and accepted local leader must be supported. A supportive community structure ideally evolves through collective efforts of residents, with the aid of an accepted local leader and, sometimes, with the support of external agents.[59]

In order for a community to be effective it must organise itself in some way. If there is no organization within the community which can serve the purpose of participation, one will have to be established. However, if an organization already exists, it is usually best to make use of that organization, because creating a new organization with firm roots in the local community is a tedious task. But even channelling community participation through an existing organization can have its disadvantages. It is essential to know whether or not the existing organization will be able to represent the entire population or only specific categories of residents.[60]

Housing Co-operatives

For the purpose of house construction a common type of community organization which has been formed in many parts of the world is the housing co-operative. Housing co-operatives have been especially popular and successful in Asia, Latin America, and South America. However, co-operative housing is still at an early stage of development in Africa. By the end of 1983 there were about 70 registered housing co-operatives in Kenya.[61]

In 1983 the Central Bureau of Statistics and the Department of Housing in the Ministry of Works, Housing, and Physical Planning carried out a survey of urban housing in thirty-two of the larger towns in Kenya. The survey indicated that the co-operative movement in general had contributed finance for the construction of 18.3% of all houses included in the survey. However, it is important to note that financing of housing by co-operatives is not necessarily through groups registered as housing co-operatives.[62]

In Kenya it is hoped that co-operative housing as a form of ownership and mode of production will help in promoting effective, broad-based access to "proper" housing for a wider range of low-income groups by: (1) mobilizing members' savings and thus introducing cheaper finance for housing development; (2) reducing costs of loan administration by facilitating disbursement to a group rather than to individuals and by collective loan repayment; (3) reducing waste of building materials; and (4) facilitating bulk purchases of building materials.[63] In addition to these four advantages, Lewin suggests that "the most significant advantage and benefit of housing co-operatives lies in their potential to promote integrated and viable urban communities and mobilize self-help sources and group dynamics."[64] Thus, the housing co-operative can offer an integrated framework, not only for the construction and management of housing, but also for a variety of social and economic activities, including improvement of health and education standards and promotion of employment opportunities.

Although co-operatives in general have contributed significantly to the financing of housing in Kenya during the last few years; many housing co-operatives, especially those formed among low-income households, have been confronted with problems that have limited their overall success. Such problems include lack of suitable and affordable land, lack of finance, and lack of technical, managerial, and administrative knowledge.[65]

The housing co-operative provides one means of organizing a supportive community for effective participation. However, there are many other types of community organizations (e.g. church groups, womens groups, or youth groups) which might be just as effective. For example, ActionAid-Kenya has been quite successful in organizing youth groups to produce low-cost local materials which can be used in building construction.

Whatever type of community organization is selected, it is important that the leader of the organization be supported by the community. In fact, it is strong leadership which forms the basis for effective self-help measures.[66]

In the IRT project the reluctance of the local community to contribute labor on a self-help basis was the result of many factors. However, there are examples of other projects in Kenya where the same technology was used and the local people did perform unskilled tasks on a self-help basis. In the construction of the Kabiro health clinic, the Institute of Cultural Affairs, a non-governmental organization which has been organizing development projects in Kabiro since 1975, was able to motivate the local people to participate in the production of soil-cement blocks and sisal-cement sheets on a self-help basis. Skilled tasks were performed by local masons and carpenters on a paid basis.

In the construction of the primary school in Mado Gashi, ActionAid worked with the Boran people to produce soil-cement blocks on a self-help basis. Again, skilled workers were paid. However, prior to this project there were no skilled workers available in Mado Gashi. Consequently, ActionAid proceeded to train previously unskilled Boran people how to perform skilled tasks in masonry and carpentry in addition to teaching them how to produce soil-cement blocks. Although there were no skilled workers in Mado Gashi prior to the start of the project; the people, with the assistance of ActionAid, were able to construct classrooms, teachers' houses, and support buildings having a total floor area of 800 m^2 in two years and for a cost of approximately Kshs.875 per m^2. In addition to the soil-cement blocks used in wall construction, the cladding material for the roof was corrugated galvanized iron sheets on a timber roof structure and the material used for the floor slab was concrete.

In 1984 ActionAid started working with a local church in the Korogocho area of Nairobi for the purpose of building a primary school. However, in this case ActionAid provided primarily financial and technical assistance. It was the local church which motivated people to contribute self-help labor to dig the foundations and fence the compound. The production of soil-cement blocks and sisal-cement pantiles was carried out by unskilled workers, but this time, they were paid a specific amount for each block and each tile produced. Again, skilled laborers were paid for the work they did. Despite the fact that both skilled workers and those producing materials were paid, the total cost for each classroom in 1985 was approximately Kshs.900 per m^2. This compares quite favorably with a cost of Kshs.2600 per m^2 for the same classroom built according to the specifications of the Nairobi City Commission. (Plate 2.1).

PLATE 2.1: CLASSROOM BUILDINGS AT KOROGOCHO

Training

The sixth requirement for effective community participation is that measures must be taken to train managers. Once leader personalities emerge and the community is motivated to action, it becomes necessary to promote managerial capabilities through educational means. Management is an important tool for achieving the objectives of a self-help project, keeping books, and making responsible decisions in financial matters. It also includes the ability to motivate people and to work out compromises between conflicting parties.[67]

In the IRT project no management training was provided for the leaders of the housing co-operatives before they assumed control of the project. Rather, the training that was provided was more technical in nature and was directed to skilled and unskilled workers from the local area who were involved in the production and assembly of building materials.

Supportive Financing System

The seventh requirement is that there must be a supportive financing system. When a financing system is being set up, financial contributions, even small ones, are necessary not only to start work but also to prove the members' interest in the joint undertaking and their readiness for active participation.[68]

While the primary source of finance for the initial phase of the IRT project was provided by an external donor, the future replication of the project was to be carried out by housing co-operatives which had been established in the study area during the course of the project. It was expected that the co-operatives would raise finance through three local sources: rent from the existing teachers' houses, membership dues from those interested in joining the co-operatives, and from the sale of shares in the co-operatives. However, the initial reluctance of the local people to join the housing co-operatives indicated that they might not have been ready to fully support the project.

Adequate Institutional Support

The eighth and final requirement for effective community participation is that there must be adequate institutional support. In low-cost housing projects there are typically three main interacting agents: (1) the local community, (2) non-governmental agencies or main supporting agencies in the field of technical and managerial assistance (e.g. HRDU), and (3) financial supporters (e.g. USAID).[69] Effective coordination among these three agents is critical to the success of the project. And the effective replication of the project is directly dependent on the degree to which technical, managerial, and financial knowledge is transferred from the main supporting agencies to the members of the local community. This transfer of knowledge must be achieved step by step in a process of learning from experience and of building from simple to complex degrees of organization.[70]

During the course of the IRT project managerial and financial knowledge was not adequately transferred from the main supporting agencies to the officials of the housing co-operatives, primarily because the co-operatives did not become functional in the local context until the end of the project. Consequently, there was very little opportunity for the transfer to occur.

Summary

In summary, one can say that community participation in the execution of low-income housing projects can be defined as the voluntary and democratic involvement of a local community in carrying out project activities during the planning, implementation, and post-implementation phases of the project. However, community participation in a project is not automatic, but rather, it will depend on many factors such as the attitude of the project staff members and the manner in which they introduce the project to the local people, the attitude of the local people, their technical skills, and the amount of time that is available to them to take an active part in the project. For community participation to be effective it will depend on these factors and several others which have already been discussed in this section.

From the experiences at Kabiro, Korogocho, and Mado Gashi one can identify several factors which contributed to effective community participation. First, the projects were of the type that would benefit the entire community directly. Second, there was daily on site supervision for each project. Third, there was a strong organization which could organize and mobilize the people for action. In the IRT project, none of these factors were present.

When community participation is effective and beneficiaries do participate in constructing their own houses, a considerable reduction in the costs of housing units can be achieved since the overheads and profits associated with the formal contractor-built method of house construction are eliminated. In fact, a survey conducted in 69 less developed countries indicated that self-help methods could reduce the total cost of house construction by an estimated average of 33 per cent.[71] Similarly, by getting local people in Bunyala and Mbita to perform unskilled tasks such as materials production on a self-help basis, it was expected that the cost of houses constructed in the IRT project could also be reduced.

Evaluation

There are many different views of what evaluation is, what it should do (i.e. its purpose), and how it should be done (i.e. the precise methodology). The United States Agency for International Development (USAID) defines evaluation as "the retrospective analysis of what happened in a development project and why; the making of judgements about the success or failure of a project."[72]

The World Health Organization defines evaluation as:

> a systematic way of learning from experience and of using the lessons learned both to improve the planning of future projects and also to take corrective action to improve existing projects.[73]

It is systematic in the sense that it uses indicators to measure the relative success or failure of the different components of a project.

E.W. Hommes states that evaluation is the scientific assessment of a project and that such an assessment can only be done on the basis of standard criteria.[74] Consequently, the criteria for evaluation are critical in an evaluation study.

In evaluations in which the emphasis is on scientific assessment and the use of indicators, C. Ossandon states that there is a tendency for the evaluation to concentrate on the end products of the project (achievement of physical objectives) and to underplay the importance of the project in the overall development of the beneficiaries. According to Ossandon the purpose of evaluation is not to evaluate a project's end products but to show its place within the development process of the beneficiary group and to relate the experience of the supporting agency (e.g. a non-governmental organization) which promoted it. The logical consequence is a form of qualitative and continuing evaluation which records the progresses and setbacks in the process of people's participation and shows the role played by the supporting agency in identifying with the local people.[75]

The author recognizes the importance of this type of evaluation. However, since the hypothesis of this study does not address itself to the overall development of the people in Bunyala and Mbita, the approach advocated by Ossandon is beyond the scope of this study. But certain aspects of his approach to evaluation such as recording the progresses and setbacks associated with people's participation and assessing the roles played by the supporting agencies in a project are included in this evaluation of the IRT project.

Evaluation Methodologies

USAID

The United States Agency for International Development states that an evaluation should do the following: (1) determine the effectiveness of a development project, where effectiveness is defined as a measure of the degree to which a project or program attains its objectives; (2) determine its significance, where significance is the degree to which a project makes a substantial contribution to development; (3) measure the efficiency of a project, where efficiency is defined as a measure of the degree to which a project or program succeeds in maximizing its beneficial results at the least cost; and (4) learn lessons from the project which can be applied to similar activities elsewhere.[76]

The degree to which effectiveness, significance, and efficiency are achieved in a project is measured by objectively verifiable indicators which help focus attention on evidence rather than on subjective opinions so that two or more people would agree that progress (i.e. a change for the better) has or has not been achieved as planned.[77] USAID, like the World Health Organization and E.W. Hommes, also emphasizes that evaluation must be done on the basis of standard criteria or indicators.

Another report prepared for USAID by two consulting firms also indicates the need to formulate a set of criteria on which an evaluation can be based. First, the report presents a set of criteria which can be used to identify successful housing schemes in developing nations. For example, the criteria for evaluating the degree to which a completed housing project can be replicated on a larger scale in the future include the following: (1) local acceptability and appropriateness, (2) reasonableness of costs to participants, (3) extent to which subsidies are used, and (4) extension of administrative mechanisms such as financing devices and agency responsibilities to future projects. In evaluating the degree to which the IRT project can be successfully replicated in the future, these criteria and others are considered. Second, by examining case studies of low-income housing projects in eleven different developing countries, the report illustrates how the criteria have been used to identify successful projects in those countries.[78]

World Bank.

The World Bank states that evaluations serve as a very important management tool. Evaluations provide information that program managers and policy planners constantly require such as information on the progress of a project, the problems it is facing, its success in achieving its objectives, and the efficiency with which it is being implemented. Evaluations also provide guidelines for the design of future projects which may be of particular interest to policy-makers. The evaluation system can improve the efficiency of project implementation by providing regular feedback on the performance of each project component as well as provide indicators on the extent to which basic project objectives are being achieved.[79]

In general, evaluation studies provide four main types of information: (1) general indicators of project progress, (2) indicators of project effectiveness, (3) indicators of project efficiency, and (4) general planning information. First, general indicators of project progress are simple numerical indicators of the progress of each of the main project components and may include financial, physical, and socio-economic aspects of the program. Evaluation of project progress corresponds to the traditional concept of monitoring.

Second, indicators of project effectiveness assess the extent to which the project is achieving its goals, both specific (such as the number of shelter units completed) and more general goals (such as impact on national housing policies). Indicators of project effectiveness may include impact on the target population, accessibility of the project to the target population, and its effect on the urban housing market and development policy.[80]

Third, indicators of project efficiency such as speed of implementation, cost, quality, and replicability assess overall project operation in terms of design, finance, implementation, maintenance, and cost recovery. They also assess the efficiency of individual project components such as technology and community participation. And finally, evaluation studies generate statistical data which can be of value to a large number of planning agencies.[81]

Like the evaluation methodology employed by USAID, the World Bank also indicates that an evaluation study should assess project effectiveness and project efficiency and that specific indicators provide a satisfactory basis on which the assessment can be made.

Summary

In summary, these different approaches seem to emphasize three key characteristics about the evaluation of housing projects. First, evaluation is a scientific assessment of a project or program. Second, the assessment should be based on objectively verifiable indicators which measure the degree to which the project has been effectively and efficiently implemented. And third, the lessons learned from the evaluation form the basis for making recommendations about how to improve the planning of future projects and how to take corrective action to improve existing projects. These three characteristics are incorporated in the evaluation of the IRT project presented in Chapter Four.

Summary

In summary, these different approaches seem to emphasize three key characteristics about the evaluation of housing projects. First, evaluation is a scientific assessment of a project or program. Second, the assessment should be based on objectively verifiable indicators which measure the degree to which the project has been effectively and efficiently implemented. And third, the lessons learned from the evaluation form the basis for making recommendations about how to improve the planning of future projects and how to take corrective action to improve existing projects. These three characteristics are incorporated in the evaluation of the IRT project presented in Chapter Four.

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Introduction

The purpose of this chapter is to describe the environment in which the IRT project was to be implemented, the characteristics of that environment that would either promote or restrict project implementation, and the proposed plan for implementation. This information is presented in two parts. The first part of the chapter describes the setting in which the Improved Rural Technology (IRT) project was to be implemented. The second part of the chapter presents a description of how the project was to be implemented.

Project Setting

According to past and present National Development Plans the need for housing in Kenya's urban and rural areas is growing at a faster rate than it can be satisfied. This growth can be attributed to limited national resources, rising costs of house construction, high building standards in urban areas, no real improvement in household incomes, and limited use of appropriate alternatives to conventional housing. As the costs of building materials and labour continue to rise, it becomes even more difficult to meet the need.

The problem of providing primary school teachers in Hakati and Mbita constituencies with improved, but affordable housing can also be attributed to some of the same factors mentioned above. The purpose of the IRT project was to introduce a more appropriate approach to house construction that would lower housing costs and yet maintain a high standard of housing quality. The approach was to be based on the use of improved indigenous building materials and construction techniques and the involvement of the people of Hakati and Mbita constituencies in the entire project process. It was thought that this approach, if successful, would lower both the cost of building materials and the cost of labour associated with house construction.

A description of the project setting in terms of the beneficiaries, their society and their environment prior to the project provides the basis for understanding both the national and local factors which affected the implementation of the IRT project. This description will examine the following factors:

(1) the physical, economic, and social aspects associated with the study area; (2) the local approach to providing teachers' houses; (3) the development of the technologies used in the IRT project; (4) the introduction of the new technologies in the study area; (5) the local political support for the project; (6) the institutional framework set up at the national level to assist housing co-operatives.

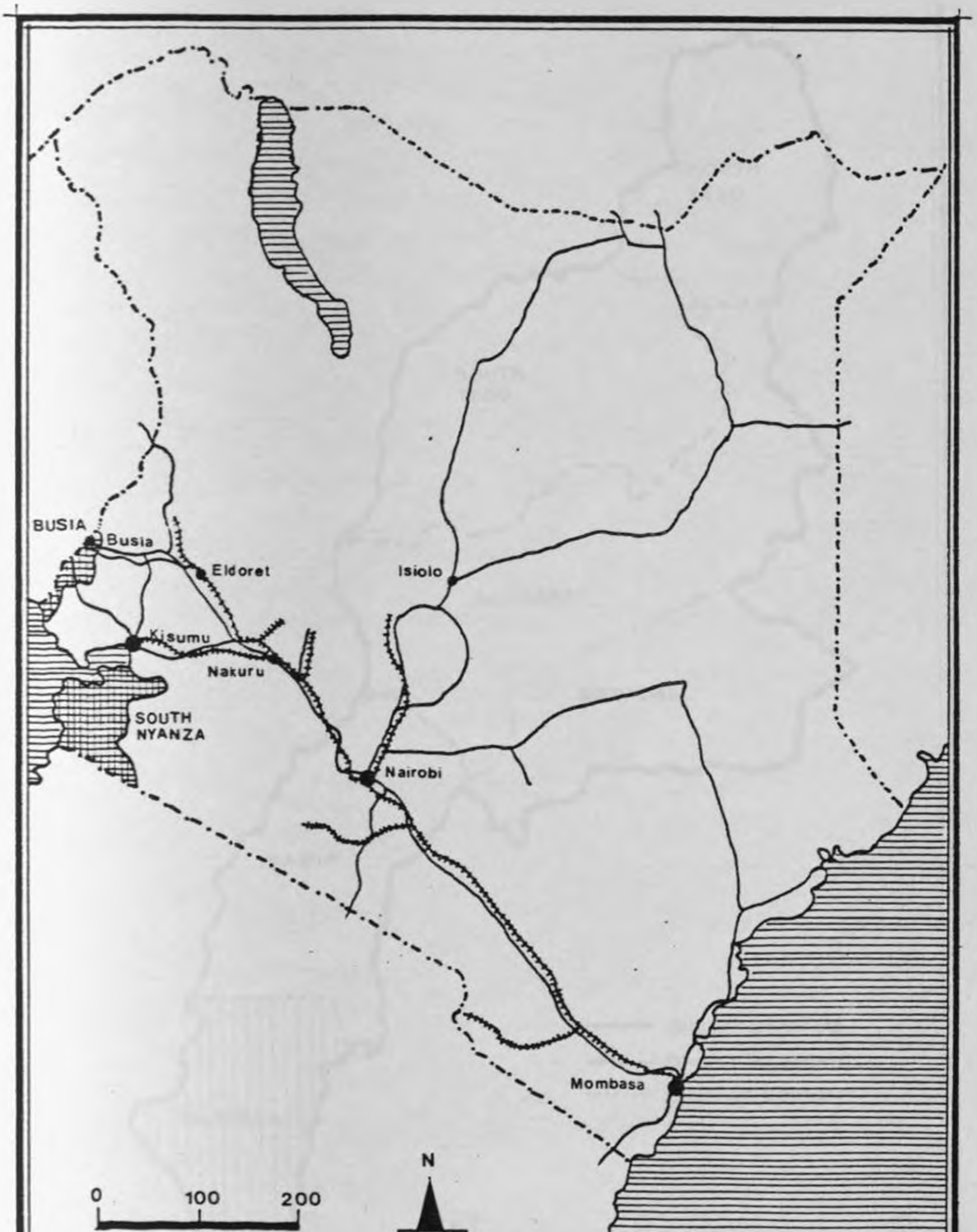
The Study Area

Location and Administrative Boundaries

Bunyala

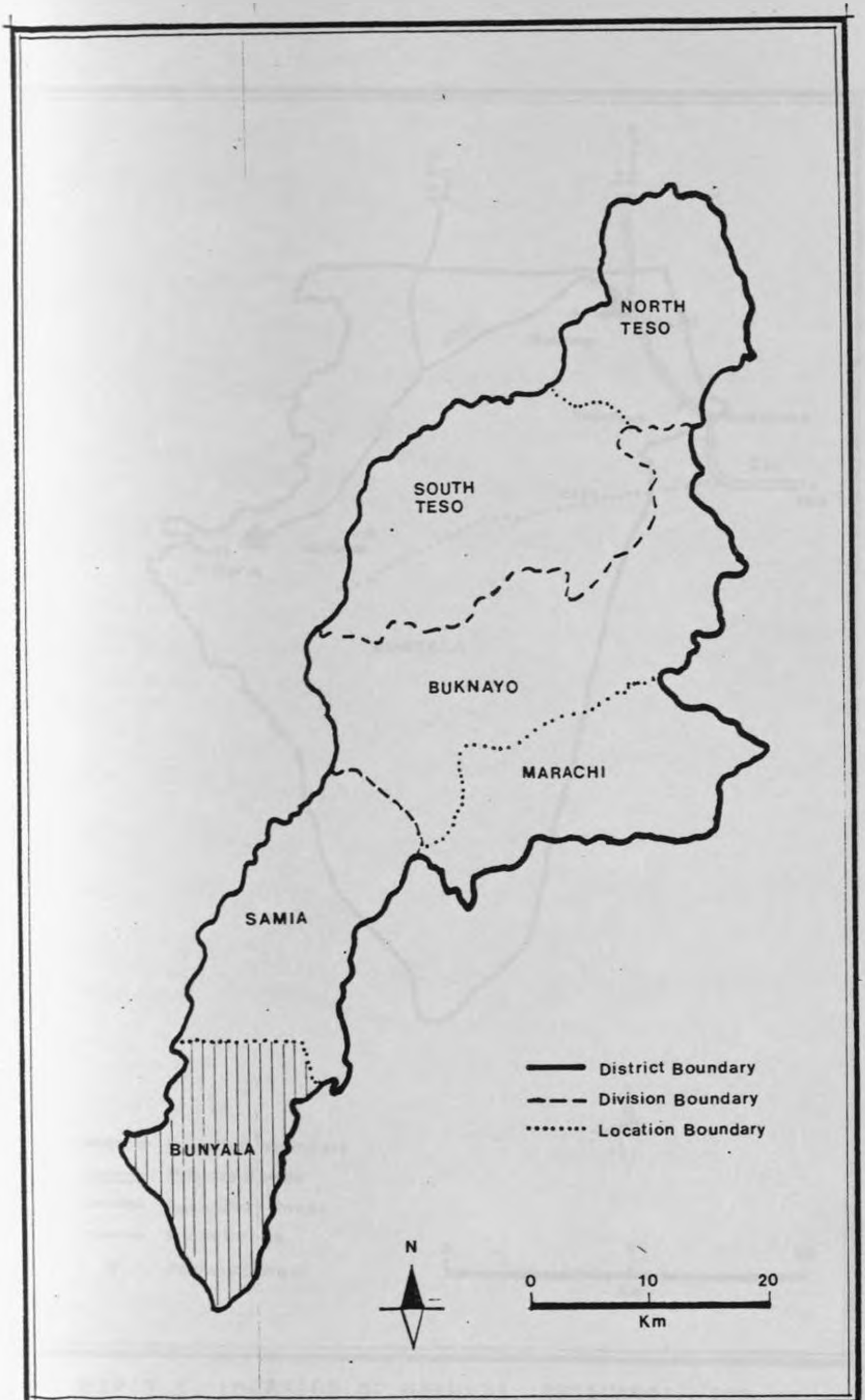
Bunyala is located on the northeast shores of Lake Victoria in the southern part of Busia District (Map 3.1). Administratively, it is one of two locations in Hakati Division (Map 3.2). Although the Improved Rural Technology (IRT) project was set up to provide teachers' housing at primary schools throughout Hakati Division; the first three schools to benefit directly from the project, i.e. Makunda, Ruambwa, and Budalangi; are all located in Bunyala location (Map 3.3).

From Map 3.3 one can see that the distances between the schools are somewhat significant, especially when one considers that the most common modes of transport in the location are by foot and by bicycle and that the surfaces of the roads linking the three schools are either murram or earth. The distance from Ruambwa to Budalangi is about 6 kilometers, and the distance from Ruambwa to Makunda is nearly 10 kilometers. However, Makunda primary school is not even connected to the others by road.



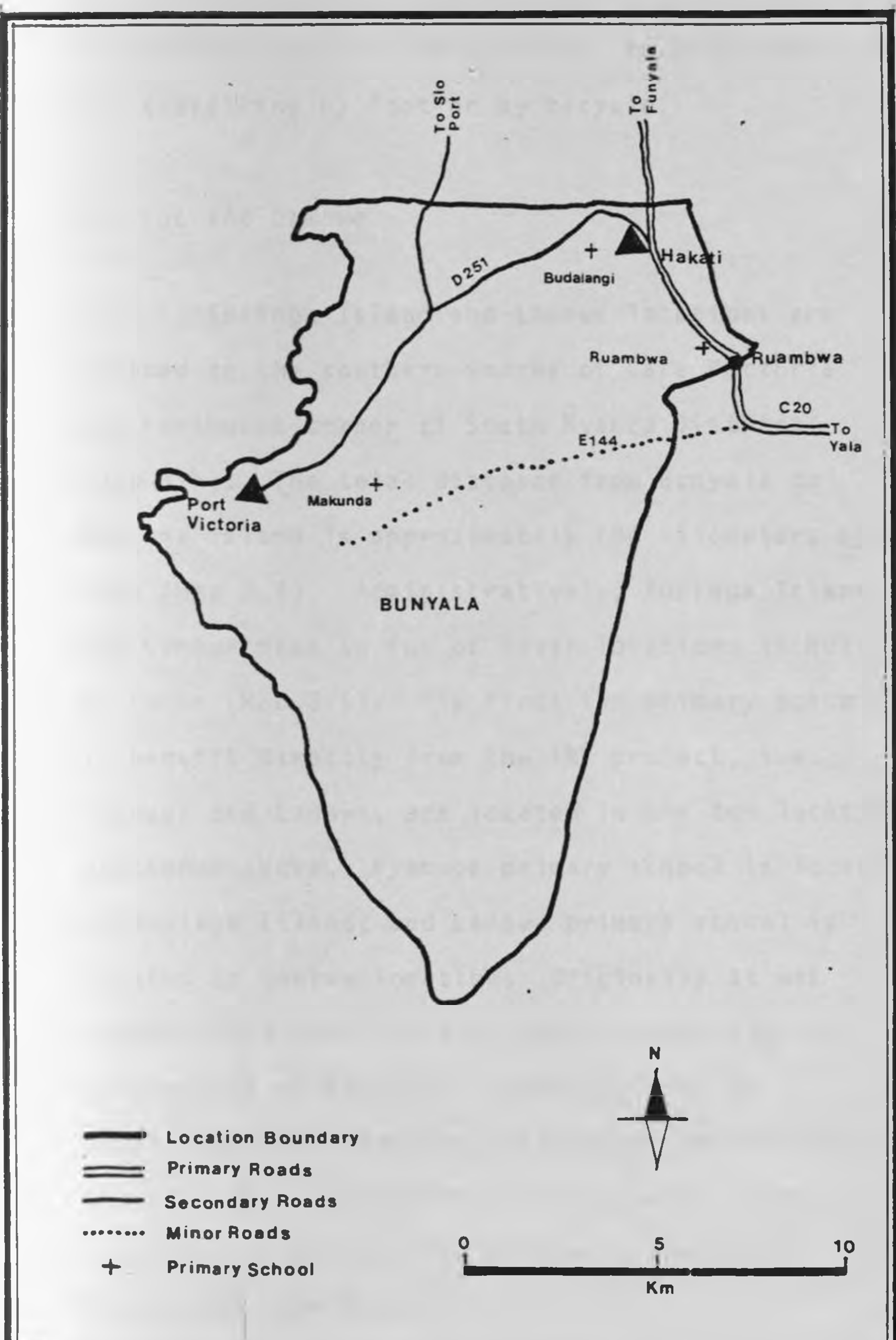
MAP 3.1: LOCATION OF BUSIA AND SOUTH NYANZA DISTRICTS IN KENYA

Source: Kingoriah, 1980.



MAP 3.2: POSITION OF BUNYALA LOCATION IN BUSIA DISTRICT

Source: 1984-88 Busia District Development Plan.



MAP 3.3: LOCATION OF MAKUNDA, BUDALANGI, AND RUAMBWA PRIMARY SCHOOLS IN BUNYALA LOCATION

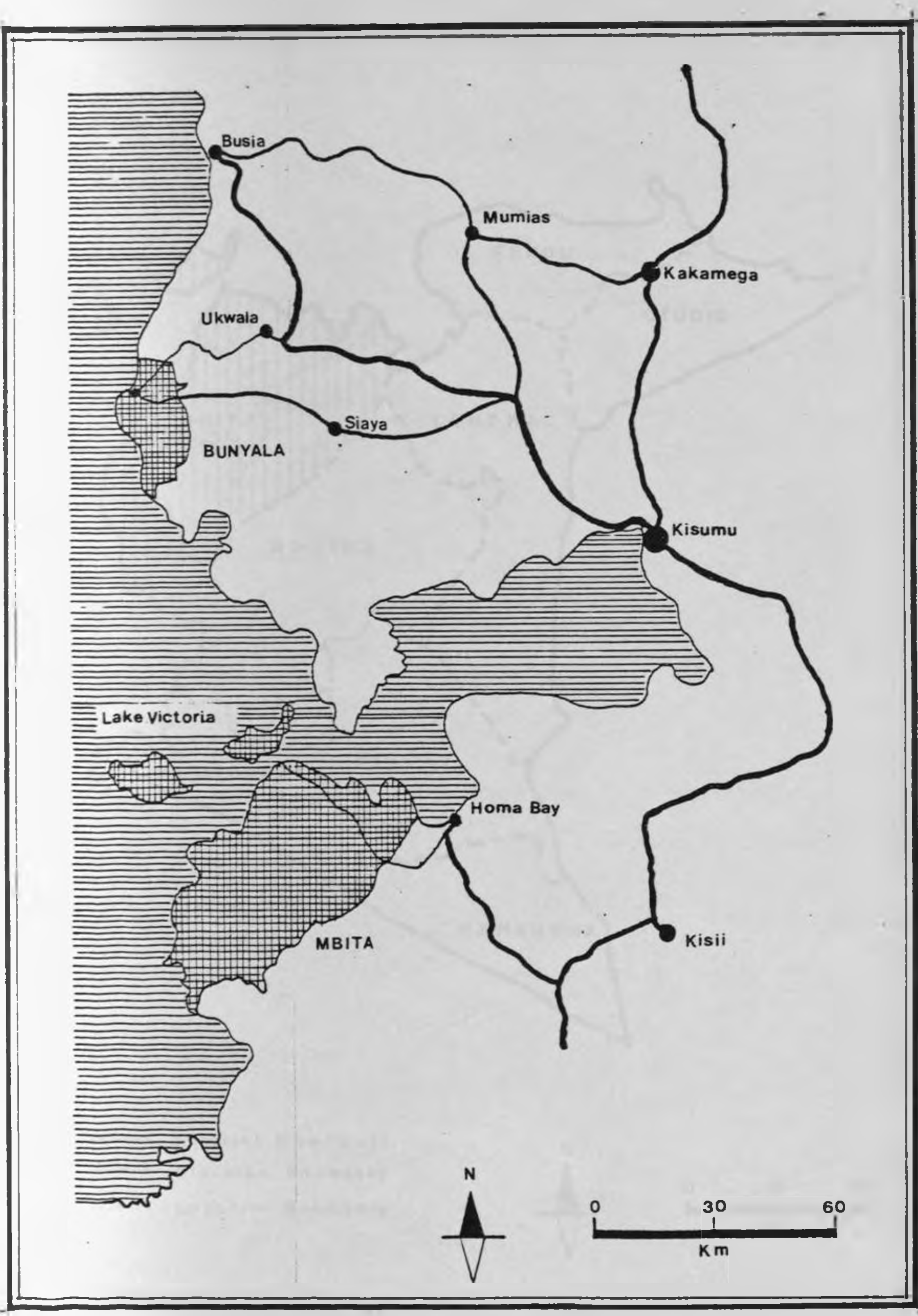
Source: 1984-88 Busia District Development Plan.

Its remote location limits access to only those who are travelling by foot or by bicycle.

Rusinga and Lambwe

Rusinga Island and Lambwe locations are located on the southern shores of Lake Victoria in the northwest corner of South Nyanza District (Map 3.1). The total distance from Bunyala to Rusinga Island is approximately 200 kilometers by road (Map 3.4). Administratively, Rusinga Island and Lambwe make up two of seven locations in Mbita Division (Map 3.5). The first two primary schools to benefit directly from the IRT project, i.e. Nyamuga and Lambwe, are located in the two locations mentioned above. Nyamuga primary school is located on Rusinga Island, and Lambwe primary school is located in Lambwe location. Originally it was thought that two teachers' houses would also be constructed at God Oloo primary school in Gwasi location. However, because of project delays, the need to pay unskilled workers, and rising construction costs; this site was eventually eliminated (Map 3.6).

From Map 3.6 one can see that the distance between the two schools is approximately 25 kilometers,

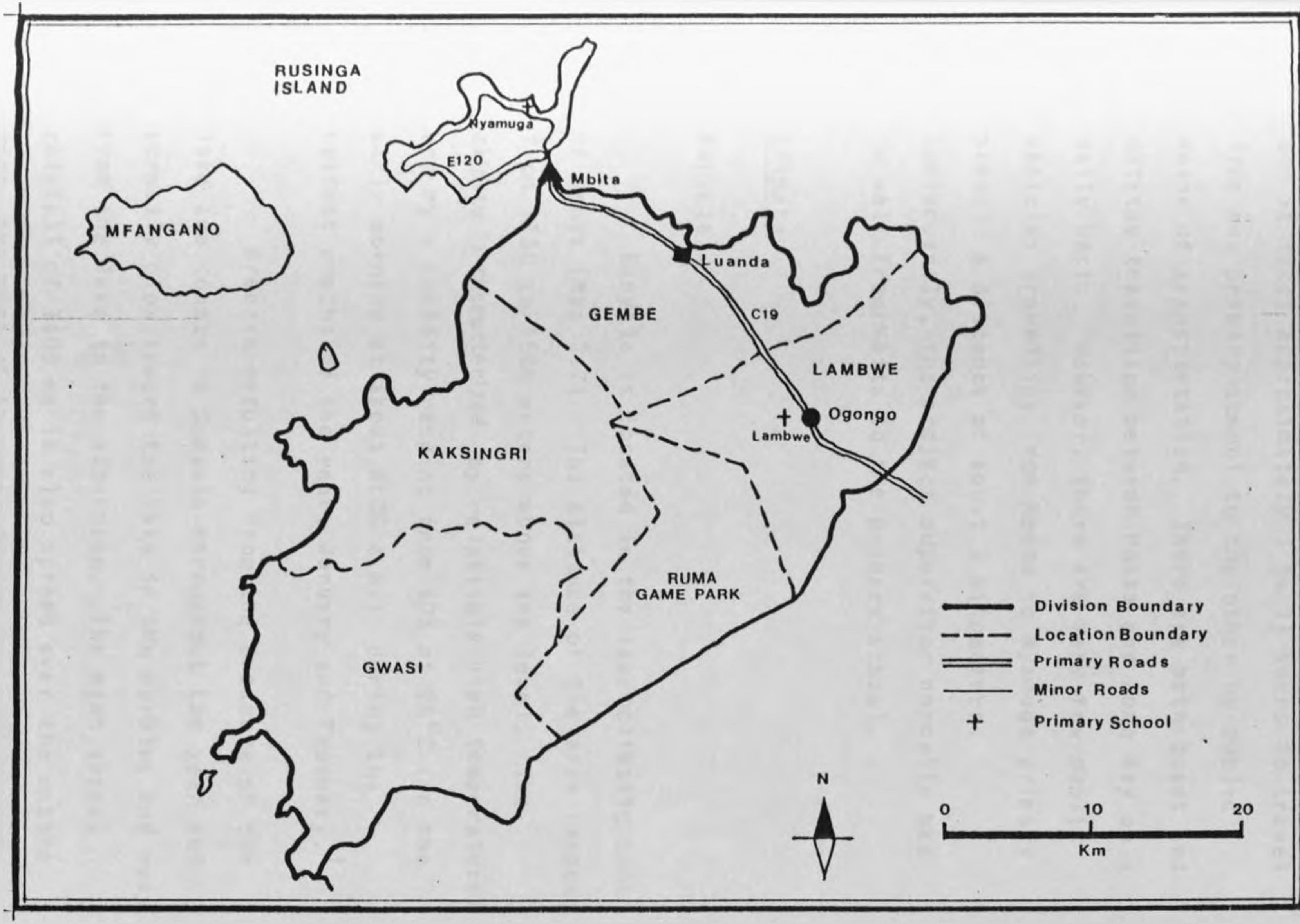


MAP 3.4: DISTANCE FROM BUNYALA TO MBITA

Source: Survey of Kenya, 1978.

MAP 3.5: LOCATION OF MBITA DIVISION IN SOUTH NYANZA DISTRICT

Source: 1984-88 South Nyanza District Development Plan.



MAP 3.6: LOCATION OF NYAMUGA AND LAMBWE PRIMARY SCHOOLS IN MBITA DIVISION
Source: 1984-88 South Nyanza District Development Plan.

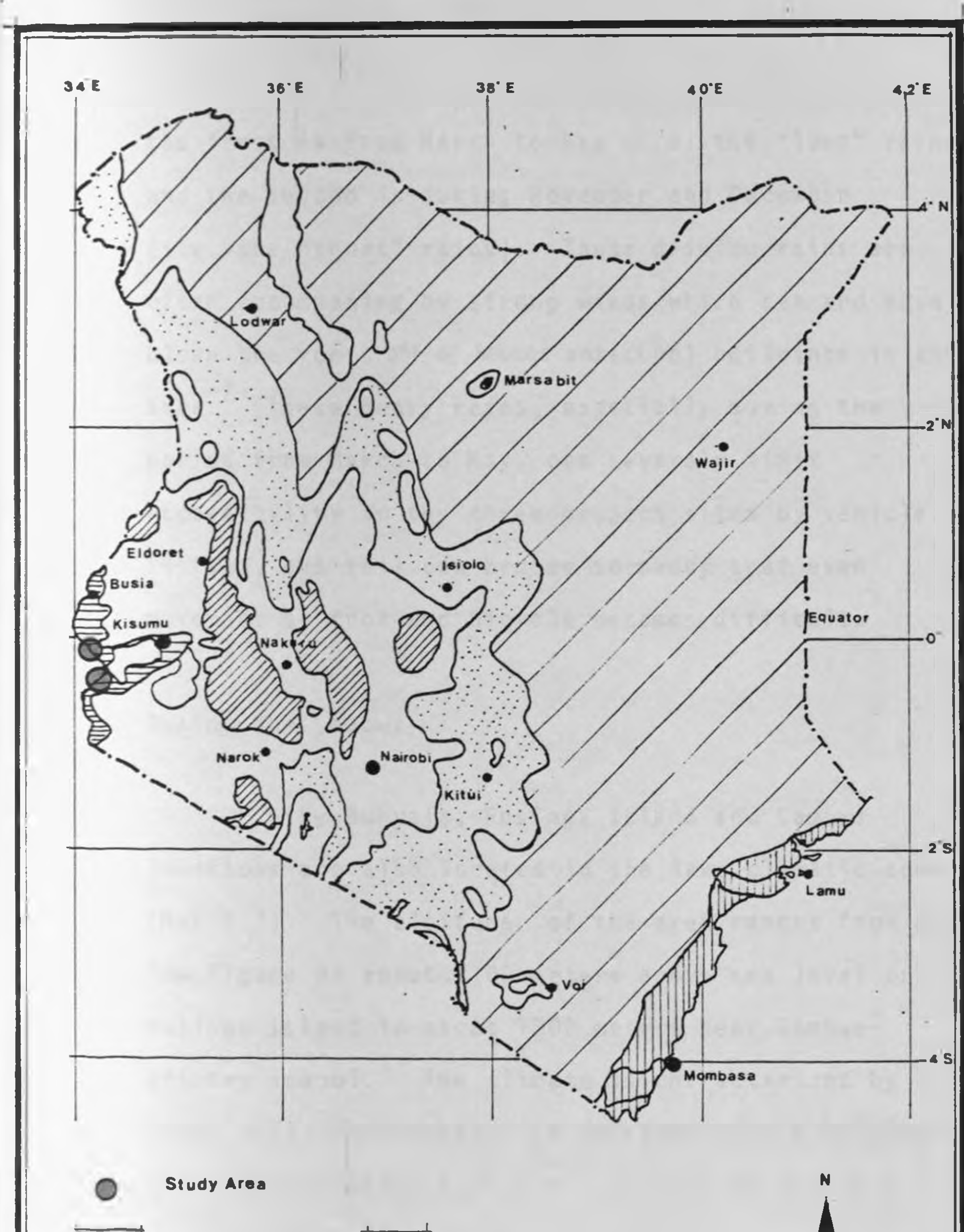
and it takes approximately 1 to 1½ hours to travel from one primary school to the other by public means of transportation. There are both buses and matatus travelling between Mbita and Homa Bay on a daily basis. However, there are very few public vehicles travelling from Mbita to Nyamuga primary school, a distance of about 3 kilometers. Consequently, the project supervisor normally had to walk from Mbita to the primary school.

Climate

Bunyala

Bunyala is located in the lake climatic zone of Kenya (Map 3.7). The altitude of the area ranges from 1130 to 1500 meters above sea level. The climate is characterized by relatively high temperatures and by a humidity ranging from 50% at 26°C (in the early morning at about 6:00 a.m.) during the hottest months of the year, January and February.[1]

Breezes resulting from the presence of the lake are common in Bunyala throughout the year and normally blow toward the lake in the morning and away from the lake in the afternoon. The mean annual rainfall of 1400 mm is also spread over the entire year, but most of it comes during two peak periods;



MAP 3.7: CLIMATIC ZONES IN KENYA

Source: Hooper, 1975.

the first is from March to May (i.e. the "long" rains) and the second is during November and December (i.e. the "short" rains). These driving rains are often accompanied by strong winds which can and have blown the roofs off of houses and school buildings in the area.[2] These heavy rains, especially during the period from March to May, can severely limit accessibility to the three project sites by vehicle. In fact, the soil can become so muddy that even movement by foot and bicycle becomes difficult.

Rusinga and Lambwe

Like Bunyala, Rusinga Island and Lambwe locations are also located in the lake climatic zone (Map 3.7). The altitude of the area ranges from a low figure of about 1100 meters above sea level on Rusinga Island to about 1300 meters near Lambwe primary school.[3] The climate is characterized by large daily fluctuations in the temperature ranging from 12^{o}C at about 6:00 a.m. to 32^{o}C at 2:00 p.m.[4]

Because of their location near the lake both Rusinga Island and Lambwe locations experience the breezes which blow towards the lake in the morning and away from the lake in the afternoon. The mean annual rainfall ranges from 800 mm at Rusinga Island to 1150 mm near Lambwe primary school.[5] Like Bunyala, most of the rain comes during two peak periods. The first is from March to June and the second is during the month of November. These rains can also be very intense and are often accompanied by strong winds and thunderstorms. Because of the poor conditions of the roads in this area these heavy rains can severely limit vehicular accessibility to the two primary schools, especially during the period from March to June.[6]

Generally one can say that the climatic conditions in Bunyala location and Mbita division are very similar. Both areas are characterized by high daily fluctuations in temperature and heavy rains which have significant implications on house design.

The heavy rains require that the walls of houses in the two areas, which are traditionally made of earth, be protected by long roof eaves. For additional protection, it is also advisable to keep the walls short (about two meters) and to apply a plaster coating to them, a coating which traditionally is made from a mixture of clay and cow dung.

Given that the daily temperatures in Bunyala and Mbita vary significantly from 12-15^{o} C at night to 26-32^{o} C during the day, it is also advisable to use heavy building materials which have good insulative values and thus maintain a thermally comfortable environment within the house. Earth is one such building material.

Soils

Bunyala

The most common type of soil in Bunyala is a sandy clay loam. Its composition is 50-80% sand, 0-30% clay, and 10-40% silt. Generally, this type of soil is very good for the production of soil-cement blocks. Because of its high sand content, the stability of the soil particles is good, and consequently, its shrinkage ratio is not too high (11-14%).[7] However, because of its relatively low clay content, the soil does not have much natural binding capacity. But with the addition of a stabilizing agent such as cement to the soil, high quality soil-cement blocks can be produced. In fact, soil-cement blocks made with this soil type experience a minimal drop in strength from the dry state to the wet state.

Rusinga and Lambwe

The type of soil at Nyamuga and Lambwe primary schools, i.e. a sandy loam, is very similar to the type of soil in Bunyala. Its sand content is slightly more and its clay content is slightly less. Consequently, its shrinkage ratio is even less; but its binding capacity and percentage drop in strength from the dry to the wet state are not as good. However, the differences between the two soil types are relatively small, and consequently, both types are appropriate for soil stabilization.

The People of Bunyala and Mbita

Although the distance from Bunyala to Mbita is quite significant and there are two different ethnic groups living in the two areas, the characteristics of the people are to some extent quite similar. Because of the close proximity of the two groups to the lake and the similar climate of the two areas, both the Luhya and Luo peoples derive their livelihood from primarily two sources, that is farming and fishing. They also have similar types of homesteads and similar types of housing.

Livelihood

In Bunyala the Luhya people constitute the dominant ethnic group. The Luhya are predominantly agriculturalists who are engaged in subsistence farming on pieces of land which on average are about 2.5 hectares in size.[8] Maize is the main crop, but a variety of other grains are cultivated, while vegetables and bananas also form an important part of the diet. A small percentage of the people supplement their income through fishing.[9]

Initially the Luo, that is the dominant ethnic group in Mbita division, were predominantly a pastoral people and cattle were highly valued. However, population growth has limited the possibilities of keeping large herds of cattle and the people have increasingly turned to agriculture. In fact, most families, as in Bunyala, are engaged in subsistence farming on small-scale holdings of about five hectares each.[10] Sorghum and maize are the main crops grown for consumption, with other types of grain such as finger millet supplementing the diet. Cassava and vegetables are also grown and fish is the main source of protein. Fishing is also quite an important source of income to about 29% of the people living in Mbita division.[11]

Because of the subsistence approach to farming, the yearly incomes of families in Bunyala and Mbita are very low. The average family of five in Bunyala has a yearly income of Kshs.2600 or less.[12] In 1979 the average net farm income for an average family of seven in Mbita division was Kshs. 1664 per annum.[13] The fact that yearly household incomes are so low is one of the reasons for the type and quality of houses one finds in Bunyala and Mbita today.

The Traditional Homestead

The agricultural activities of both the Luhya and Luo peoples are reflected in the traditional pattern of settlement where each homestead is surrounded by the amount of land required to produce enough food for the family plus a small surplus. In terms of the individual homestead it is thought that defense was probably the main criterion in determining its layout. Normally the traditional homestead is circular in plan and often has earth walls and moats surrounding it for protection. However, today the walls and moats have generally been replaced by hedges of euphorbia shrubs.[14]

The houses are built on the periphery of the homestead enclosure and outside the inner cattle enclosure, called the kraal. The number of houses within the enclosure depends on the size of the family. For example, the number of houses in a typical Luo homestead might vary from 2 to 20.[15] A typical arrangement of a Luo homestead is shown in Figure 3.1.

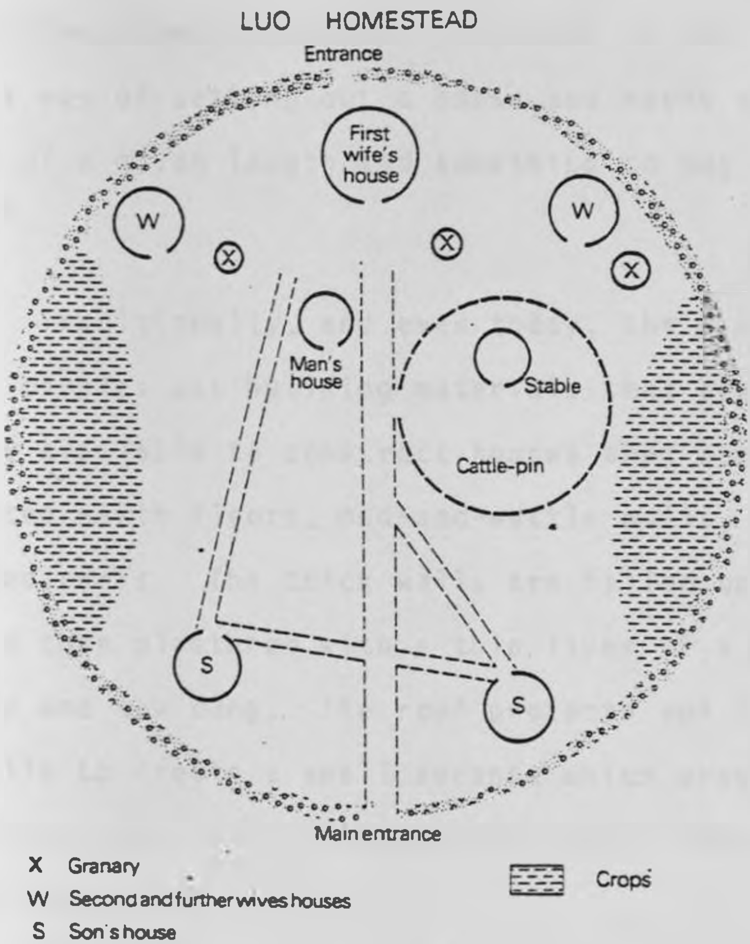


FIGURE 3.1: TRADITIONAL LUO HOMESTEAD

Source: Sterkenburg, 1982, p.30.

House Types

Like the traditional Luhya and Luo homestead, the plan of the traditional house is also circular. The round type of house did not develop accidentally but for functional purposes. A circle is the easiest way of setting out a house and needs only a string of a given length and something to peg it down.[16]

Traditionally, and even today, the Luo and Luhya peoples use building materials that are locally available to construct houses that have compacted earth floors, mud-and-wattle walls, and thatched roofs. The thick walls are filled up with mud and then plastered with a thin layer of a mixture of clay and cow dung. The roof projects out from the walls to create a small veranda which provides shade from the sun and protects the walls from the rain (Figure 3.2).

In Bunyala, such a house, having an area of 25 m^2 and made with the materials described above, currently costs about Kshs.2000 to build, of which, Kshs.1250 is spent on the roof. The earth itself, as a building material, is very cheap (most likely free), readily available near the building site, easy to work with, and requires only simple tools which

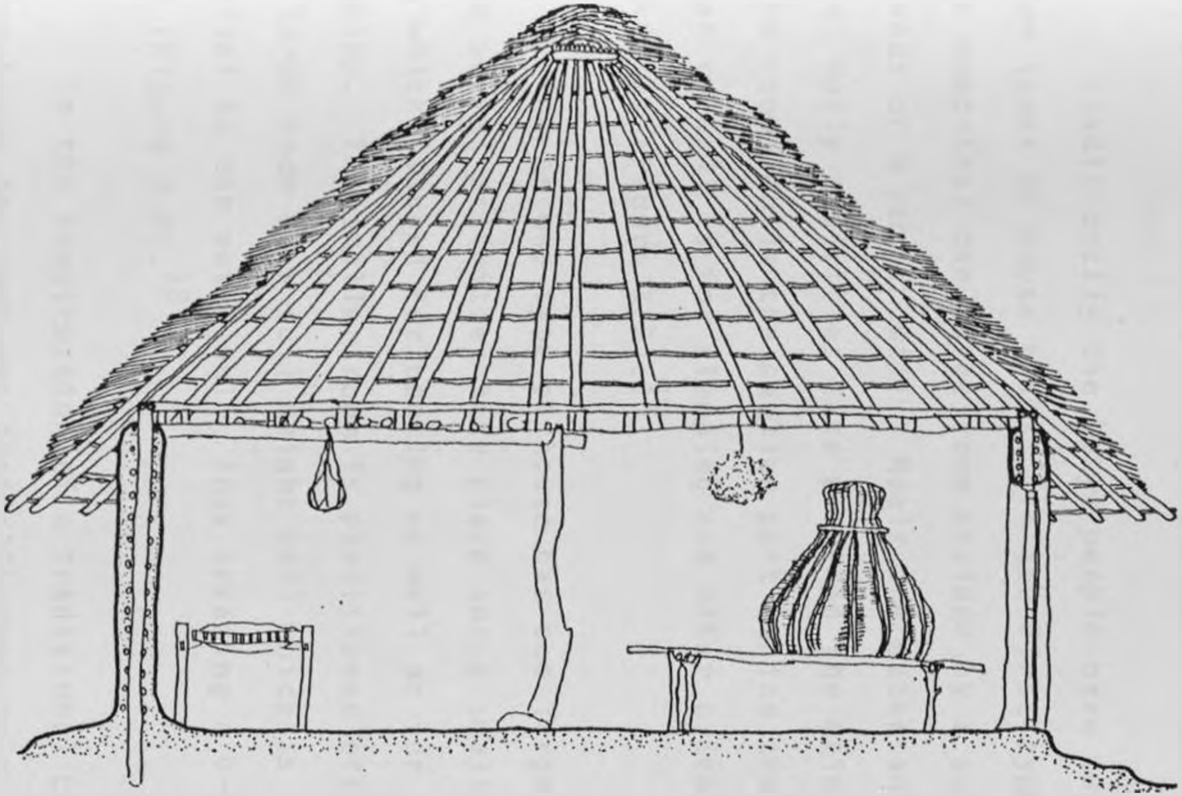


FIGURE 3.2: TRADITIONAL HOUSE CONSTRUCTION

Source: Andersen, 1977.

most rural families can afford. However, thatch is becoming scarce in both Bunyala and Mbita and is now almost as expensive as corrugated iron sheets, primarily as a result of high transport costs.

Traditionally the Luhya people have two common types of house plans. In the first type the house comprises one large room divided by a screen of reeds or a partial wall. Meals are eaten and normal daily activities take place in the main part of the room, while the smaller part behind the screen or wall is for sleeping and other private activities (Figure 3.3).[17]

The second type of house has one large room where social activities take place and a smaller room which is used for cooking as well as for sleeping. The smaller room is partitioned off from the large room by a full height wall which is parallel to the outer wall, thus creating a U-shaped room (Figure 3.4).[18]

In the construction of a traditional Luhya or Luo house the work was typically done on a harambee basis, provided the local community was informed ahead of time. However, when specialized skills were required for construction of the roof structure or roof thatching, skilled craftsmen were

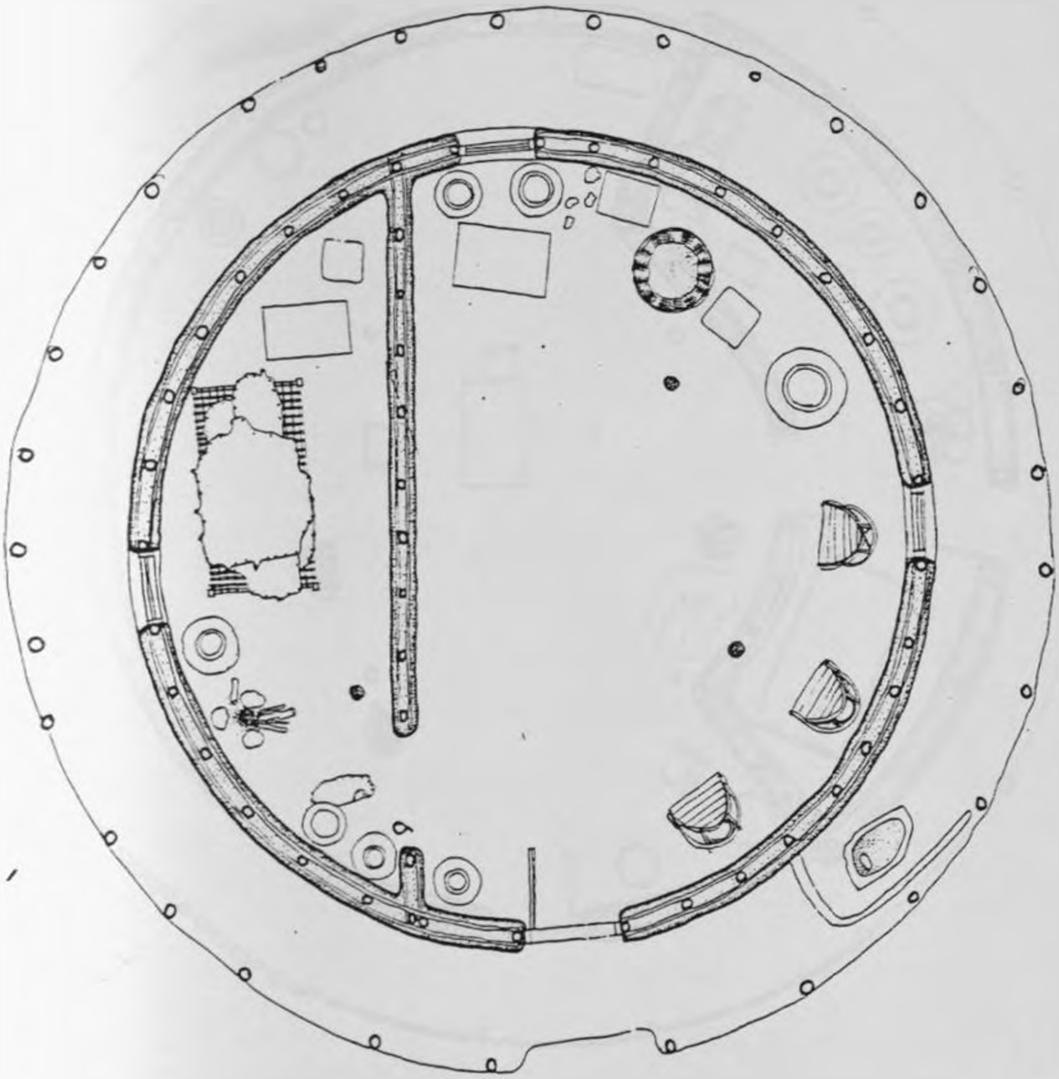


FIGURE 3.3: PLAN OF A TRADITIONAL LUHYA HOUSE

Source: Andersen, 1977.

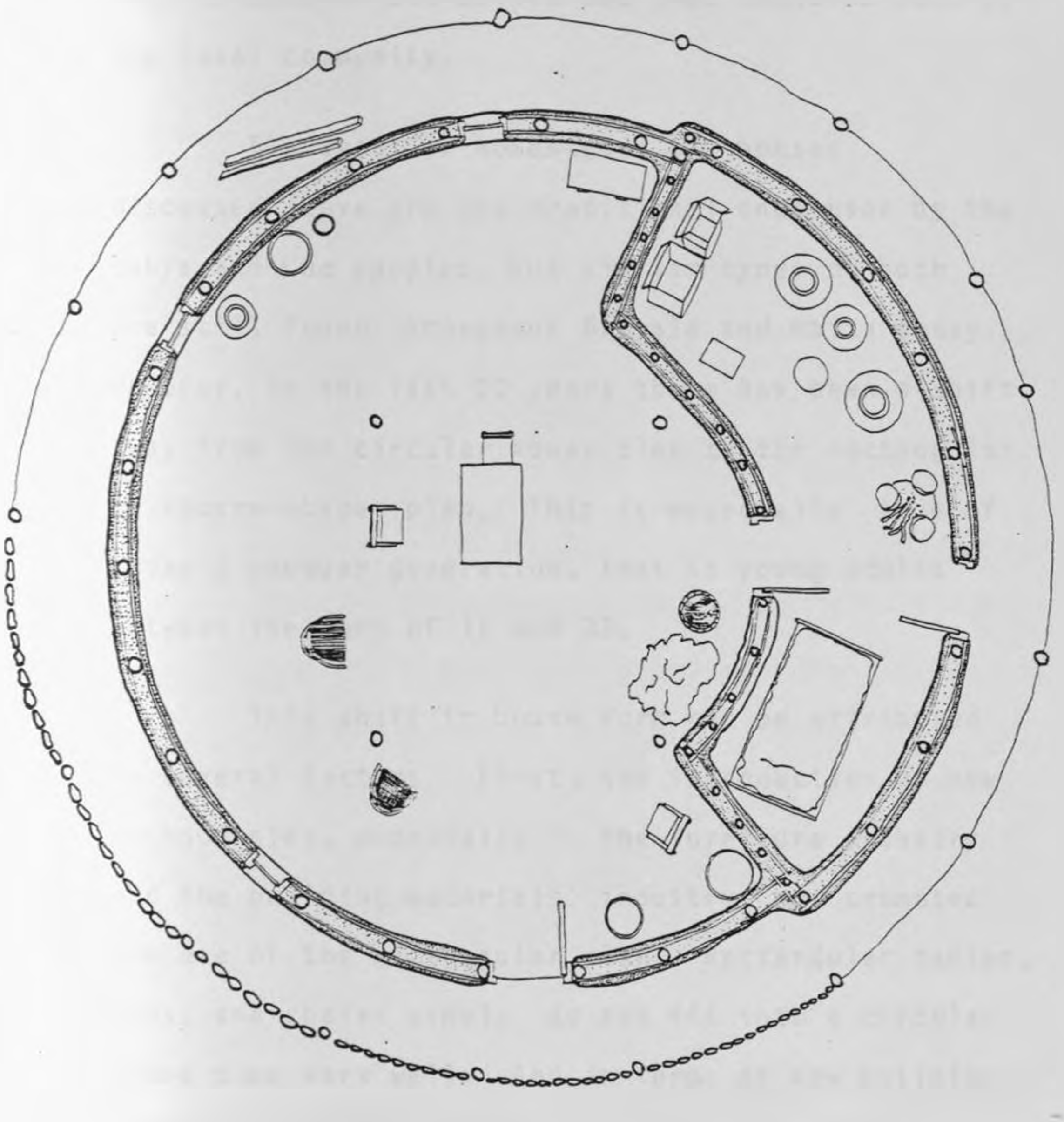


FIGURE 3.4: PLAN OF A TRADITIONAL LUHYA HOUSE

Source: Andersen, 1977.

sometimes employed. Construction of walls did not require specialized skills and thus could be done by the local community.

The types of homesteads and houses discussed above are the traditional ones used by the Luhya and Luo peoples, but similar types of both are still found throughout Bunyala and Mbita today. However, in the last 20 years there has been a shift away from the circular house plan to the rectangular or square-shaped plan. This is especially true of today's younger generation, that is young adults between the ages of 18 and 30.

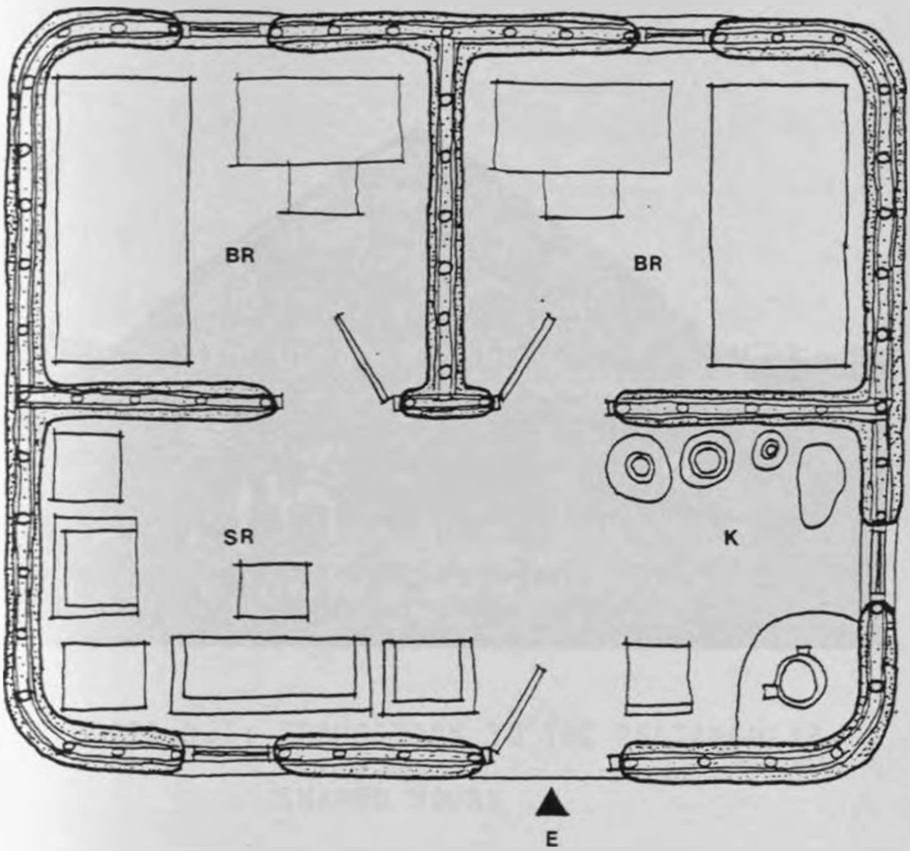
This shift in house form can be attributed to several factors. First, the introduction of new technologies, especially in the furniture industry and the building materials industry, has promoted the use of the rectangular plan. Rectangular tables, beds, and chairs simply do not fit into a circular house plan very well. And in terms of new building materials, the use of iron sheets as a roofing material has also altered the shape of the house from circular to rectangular.[19]

Second, the activities taking place in Kenya's urban areas are seen by rural communities as being progressive and "modern". Consequently, a rural man who has a rectangular type of house like those in the urban areas is also considered by his neighbours to be a bit more progressive. The type of house one owns has become a status symbol.

Third, the rectangular shape is more practical for partitioning a house into smaller rooms, some of which are more public while others are more private. The combination of smaller rooms and rectangular pieces of furniture makes the rectangular-shaped house much more suitable (Figure 3.5).

Although the shape of the house is shifting from a circular form to a rectangular form, the building materials used by most rural families in Bunyala and Mbita have remained the same. Their houses continue to have compacted earth floors, mud-and-wattle walls, and in many cases thatched roofs (Plate 3.1). However, the use of iron sheets as a roofing material is becoming much more common.

The main reason for the continued use of traditional materials is that most rural families cannot afford to use conventional building materials. However, families in Bunyala and Mbita who do have higher incomes are building houses with conventional building materials like concrete block, stone, and iron sheets.



LEGEND

BR Bedroom

SR Sitting Room

K Kitchen

E Entrance

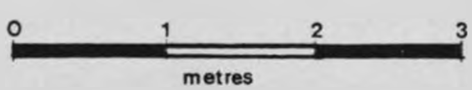


FIGURE 3.5: TRANSITION TO THE RECTANGULAR-SHAPED HOUSE

PLATE 3.1: TRANSITION TO THE RECTANGULAR SHAPED HOUSE

Statement of the Problem (Local Context)

In Bunyala and Mbita, as in most parts of Kenya, primary school development is done on a harambee (self-help) basis, organized through the School Parents Associations. Given that most families in these areas have yearly incomes which are extremely low and that the cost of building better houses using conventional building materials and construction techniques is relatively high, it is not surprising that many primary schools in these areas have no housing for teachers. And if the schools do have teachers' housing, in most cases the houses have been built with traditional building materials.

This reality in conjunction with the fact that the people in Bunyala and Mbita do not know how to produce improved indigenous building materials with which to construct better houses that more of the rural people can afford, results in a lack of acceptable houses for primary school teachers near their place of work. For example, in Bunyala there are no houses for teachers at Makunda, Ruambwa, and Budalangi primary schools. At Nyamuga and Lambwe primary schools in Mbita division, there are teachers' houses, but they have been built with traditional materials. Because of the low quality of these houses, many remain unoccupied. Teachers prefer to use their government housing allowance to rent relatively higher quality houses elsewhere.

As a result, most teachers must travel long distances daily to reach the schools in which they teach. For example, some teachers in Bunyala travel up to 16 kilometers every day to and from school. And teachers at Nyamuga and Lambwe primary schools travel up to 10 kilometers round trip on a daily basis. Travelling such distances on a daily basis significantly decreases the effectiveness with which teachers can fulfil their responsibilities.

In summary one can say that the main problem which gave rise to the IRT project was the need to provide teachers with housing that was low-cost, yet high in quality, and near the primary schools.

Local Approach to the Problem

When confronted with the task of providing primary school teachers with housing, parents in Bunyala and Mbita have historically organized themselves through the structure of School Parents Associations (SPAs) to build houses on a self-help basis. School Parents Associations are formed for each school in Kenya to take collective responsibility for planning and handling all matters related to the school's well-being. The School Parents Associations are mainly composed of teachers, parents, and the founders of the school or their representatives. One of the main functions of this organization is to find suitable accommodation for headmasters and the rest of the teachers posted or transferred to work in their schools.

In the past, the School Parents Associations at Lambwe and Nyamuga primary schools have been especially successful in mobilizing parents and children to build teachers' houses with traditional building materials (Plate 3.2).

PLATE 3.2: TEACHERS' HOUSE AT LAMBWE PRIMARY SCHOOL

For example, at Nyamuga primary school members of the School Parents Associations met and decided on the number of teachers' houses they wanted to build, where they would build them, and when they would build them. As a group they chose to construct the houses using traditional building materials and construction techniques since parents and children were already familiar with both. They also decided that parents and children would collect the necessary building materials, transport them to the site, and provide the labour needed to build the houses.

After the initial meeting of the School Parents Association in which most of the major decisions were made, the headmaster of the school was appointed by the School Parents Association to coordinate the house construction process. Prior to the days set aside for the construction of the houses, he asked each pupil to bring certain materials such as sand, tools, timber, and water on the assigned days. Through consultation with parents he also set up a work schedule so that parents would know on which day they were expected to work.

As a result of this planning, both materials and labour were available on the day house construction was to begin. Men were responsible for the construction of walls and roofs while men, women, and children participated in packing the walls with mud. The basic structure for organizing primary school construction activities, including the responsibilities of each of the participants, is presented in Figure 3.6. From Figure 3.6 one can see that it is sometimes desirable to hire skilled or semi-skilled workers to build the needed structures. This is often the case when the structure is built with conventional building materials. The skilled worker may employ casuals to help him, but members of the community can still participate in collecting materials such as sand, stones, and mud and in transporting them to the site.

The approach used at Nyamuga primary school to build teachers houses had several advantages. The local people identified the problem themselves, and they knew that they were the only ones who would do something about it. Consequently, they organized themselves for action and appointed an accepted local leader (i.e. the headmaster) to coordinate the construction process. Because all of the people knew what needed to be done and how to do it and since the labour component had been organized ahead of time, the houses were completed in a few days. The speed of implementation was excellent. Through the successful completion of the project, community social ties were strengthened

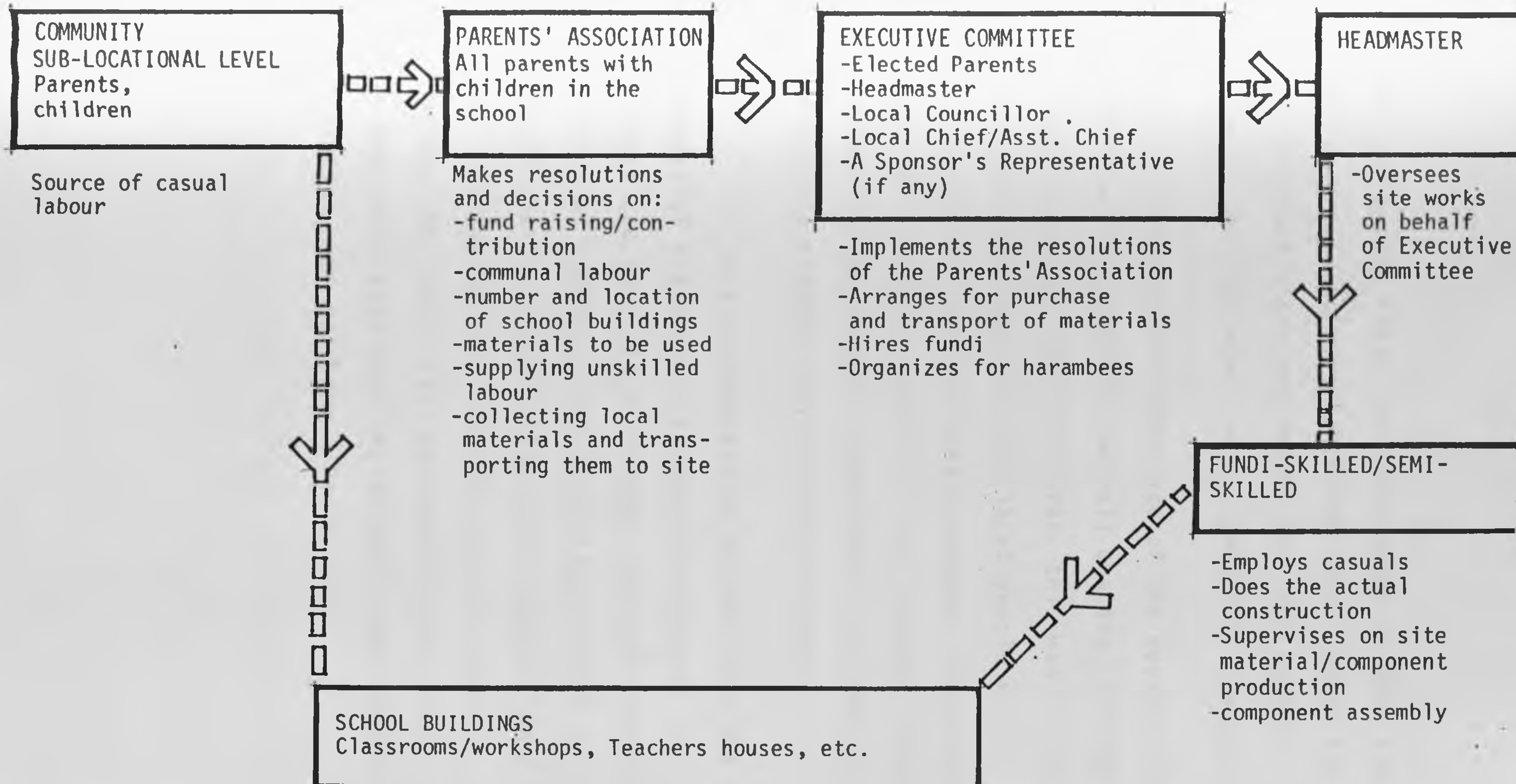


FIGURE 3.6: BASIC FRAMEWORK FOR ORGANIZING PRIMARY SCHOOL CONSTRUCTION ACTIVITIES.

Source: Faculty Projects Office, University of Nairobi, 1985, p.53.

and the people could look with pride on what they had been able to accomplish together. Since the building materials and labour had been donated freely, the completed houses were truly low cost.

The major disadvantage of the approach used at Nyamuga was that the overall quality of the houses was poor. But of course, this was a direct result of the fact that the local people were limited by the skills they possessed. And now, because of the poor quality, many teachers refuse to live in the houses. They prefer to rent relatively higher quality houses elsewhere.

It is also interesting to note that the members of the School Parents Association at Nyamuga saw the need to provide teachers with a higher quality of housing. The first houses built by the School Parents Association had thatched roofs, but a few years later the decision was made to replace the thatch with corrugated iron sheets. However, not even this improvement seems to have satisfied the teachers (Plate 3.3).

PLATE 3.3: TEACHERS' HOUSE AT NYAMUGA PRIMARY SCHOOL

In summary one can say that the School Parents Associations at Lambwe and Nyamuga primary schools did have a solution for providing teachers with houses. The only problem was that the teachers were not satisfied with the quality of the end product. Consequently, there was a need for the development of a new technology which would satisfy the teachers' demands for quality and yet remain affordable to the School Parents Associations.

Development of the New Technology

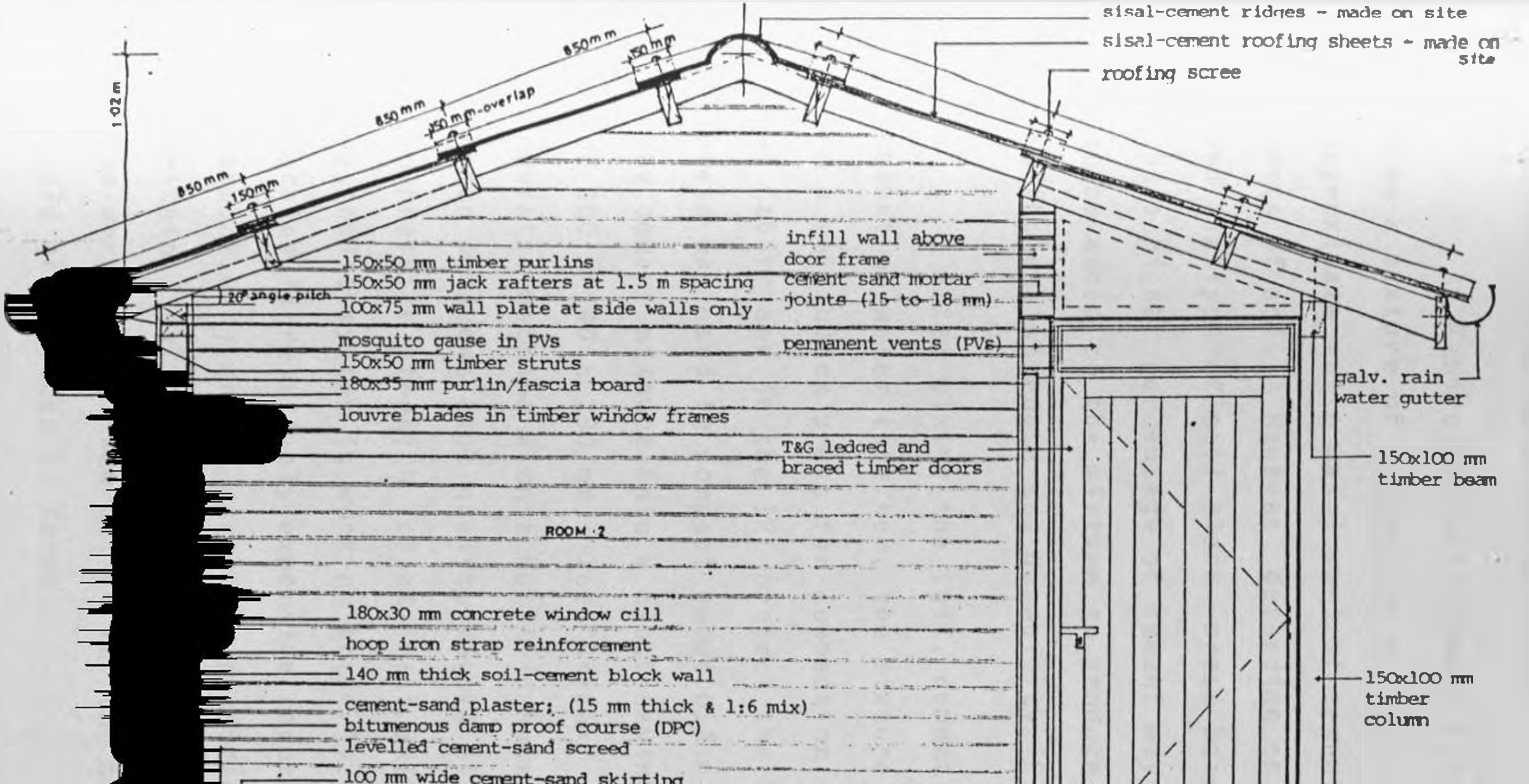
Since the mid-1970s research institutions in Kenya such as the Housing Research and Development Unit and the Department of Civil Engineering at the University of Nairobi, the Karen Center for Research and Training, and the Appropriate Technology Center at Kenyatta University have been developing appropriate building technologies which emphasize the use of locally available materials in house construction. Such technologies reduce the cost of housing to a level that is about half that of conventional housing and yet retain a relatively high level of quality. The technologies developed include the use of soil-cement blocks for the construction of load bearing walls and the use of corrugated sisal-cement sheets as a roofing material. HRDU has satisfactorily tested these new technologies in the construction of a three-roomed demonstration health clinic at Kabiro Village in the Kawangware "squatter" area of Nairobi. The health clinic was completed in October of 1981, and to date, the soil-cement blocks and sisal-cement sheets have performed quite satisfactorily (Plate 3.4).

PLATE 3.4: KABIRO HEALTH CLINIC
Source: HRDU.

Description of the Technology

In the Kabiro health clinic the walls of the building are constructed of 140 mm thick stabilized soil-cement blocks made with the "Brepak" block press which was developed by the Building Research Establishment in Britain. The building has a strip concrete foundation. Concrete blocks were used to construct the foundation wall up to the damp proof course. The flooring consists of a 75 mm thick concrete floor slab on 150 mm thick hard core with a 20 mm thick cement screed finish. On top of the bituminous damp proof course, stabilized soil-cement blocks were laid using sand-cement mortar joints. Hoop iron strap reinforcement was inserted in every third block course to prevent any possible crack in the wall due to differential settlement of the building. Deep timber purlins (150 x 50 mm) span between load-bearing walls and serve as support members for the heavy sisal-cement roofing sheets, each of which has a weight of 17 kg. and an area of approximately 1 m^2 (Figure 3.7).[20]

The exterior of the walls have a fair-faced block wall finish, while 50% of the inside finish is plastered and painted and the rest is only painted. Maximum use of indigenous building materials has been achieved through the use of soil-cement blocks for wall construction, sisal-cement sheets for roofing, and timber for the doors, window frames, shutters, and roof structure. The basic components of the health clinic construction as described above are almost identical to those of the teachers' houses which were built in Bunyala and Mbita.


sisal-cement ridges - made on site
sisal-cement roofing sheets - made on site
roofing scree
850mm
150mm
850 mm
150 mm-overlap
850mm
150 mm
1.02 m
150x50 mm timber purlins
150x50 mm jack rafters at 1.5 m spacing
20° angle pitch
100x75 mm wall plate at side walls only
mosquito gause in PVs
150x50 mm timber struts
180x35 mm purlin/fascia board
louvre blades in timber window frames
infill wall above door frame
cement sand mortar joints (15 to 18 mm)
permanent vents (PVs)
T&G ledged and braced timber doors
galv. rain water gutter
150x100 mm timber beam
ROOM 2
180x30 mm concrete window cill
hoop iron strap reinforcement
140 mm thick soil-cement block wall
cement-sand plaster; (15 mm thick & 1:6 mix)
bitumenous damp proof course (DPC)
levelled cement-sand screed
100 mm wide cement-sand skirting
150x100 mm timber column

Production of Soil-cement Blocks

At Kabiro the soil-cement blocks were made from a mixture of cement and soil in which the approximate ratio was 1 part of cement for every 20 parts of soil. However, depending on the type of soil and the type of soil block press being used, sand and a higher percentage of cement may sometimes have to be added to the mixture to produce blocks having sufficient strength and durability (Plate 3.5).

After mixing the soil, cement, and a small amount of water together; the mixture is then placed in a soil block press for compaction (Plate 3.6). At Kabiro and in the IRT project the "Brepak" block press was used to compact about 0.3 m^3 of the soil and cement mixture into a block having dimensions of 100 x 140 x 290 mm. The "Brepak" is a hand-operated machine with a built-in hydraulic system which produces high quality blocks having a compressive strength of at least $3N/mm^2$ when the hydraulic system is working properly. However, the machine is relatively expensive (approximately Kshs.22,000) and is currently produced only in Britain. But the Building Research Establishment is now working on a new design for the machine which could be produced in Kenya.

After compacting the blocks in a soil block

PLATE 3.5: MIXING OF SOIL AND CEMENT

Source: HRDU.

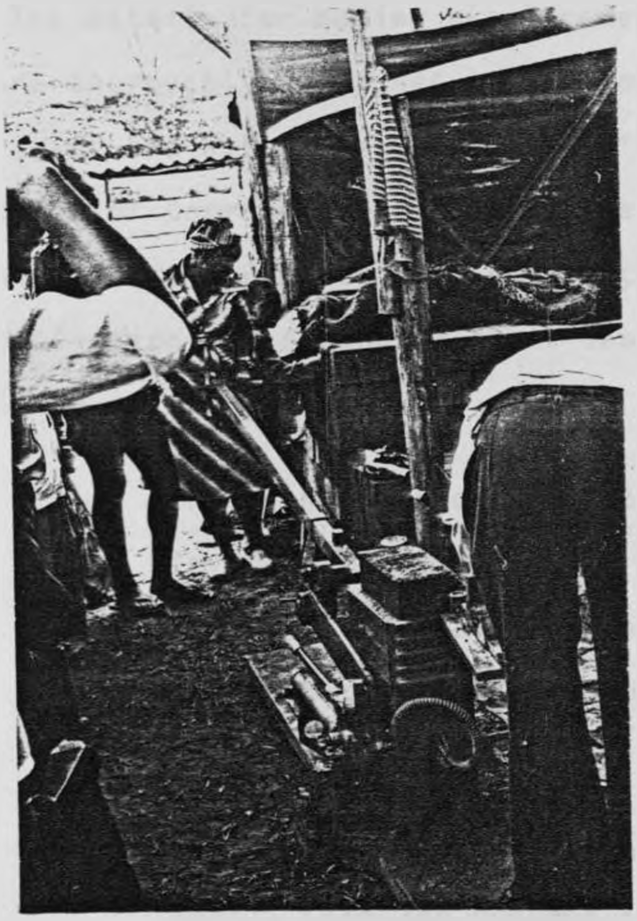


PLATE 3.6: COMPACTION OF SOIL-CEMENT BLOCKS

Source: HRDU.

press, they have to be kept in a shed or covered for at least two days to allow them to harden in their pressed shape (Plate 3.7). After this initial curing stage, they can be piled up to a maximum of 10 layers and then covered for an additional 26 days of natural curing before using them (Plate 3.7). During very hot and dry days, sprinkling water on the covered blocks is necessary to ensure that the blocks cure properly.

Production of Sisal-cement Roofing Sheets

The details for making sisal-cement roofing sheets are thoroughly explained in a report prepared by D.G. Swift and R.B.L. Smith entitled "The Construction of Corrugated Roofing Sheets Using Sisal and Cement." However, the key stages involved in the production and curing of sisal-cement sheets are outlined below:

(i) Sieving sand through a 1.5 x 1.5 mm sieve and chopping 25% of 0.5 kg. of sisal into small lengths of less than 30 mm. These are enough sisal fibers for one sheet.

(ii) Weighing and thoroughly mixing cement, sand and chopped sisal for one sheet. The appropriate mixture

PLATE 3.7: CURING OF SOIL-CEMENT BLOCKS

Source: HRDU.

requires 10 kg. of cement, 5 kg. of fine sand, and 25% of the 0.5 kg. of sisal (Plate 3.8).

PLATE 3.8: MIXING OF CEMENT, SAND, AND CHOPPED SISAL
Source: HRDU.

(iii) Adding moisture in small amounts and continuing to mix until a workable mixture is obtained.

(iv) Preparing a flat sisal-cement sheet in a mould board using all the sisal and the mixture to form at least two cross layers of sisal and the mixture (Plate 3. 9).

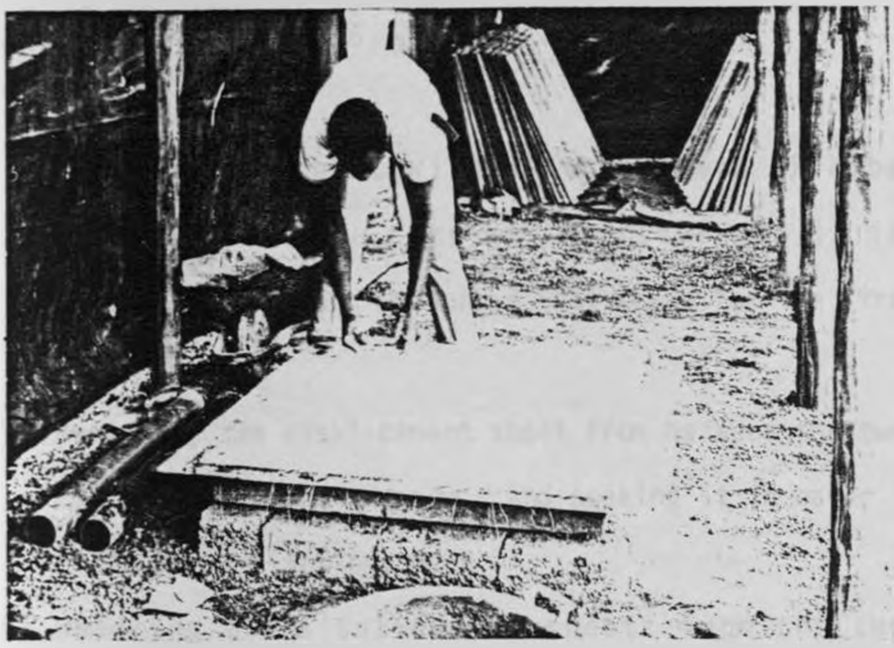


PLATE 3.9: PREPARING A FLAT SISAL-CEMENT SHEET
Source: HRDU.

(v) Moving the flat sisal-cement sheet from the mould board to the corrugated concrete base with a 1 meter long super-seven asbestos sheet inserted and then pressing the sisal-cement sheet into the corrugations (Plate 3.10).

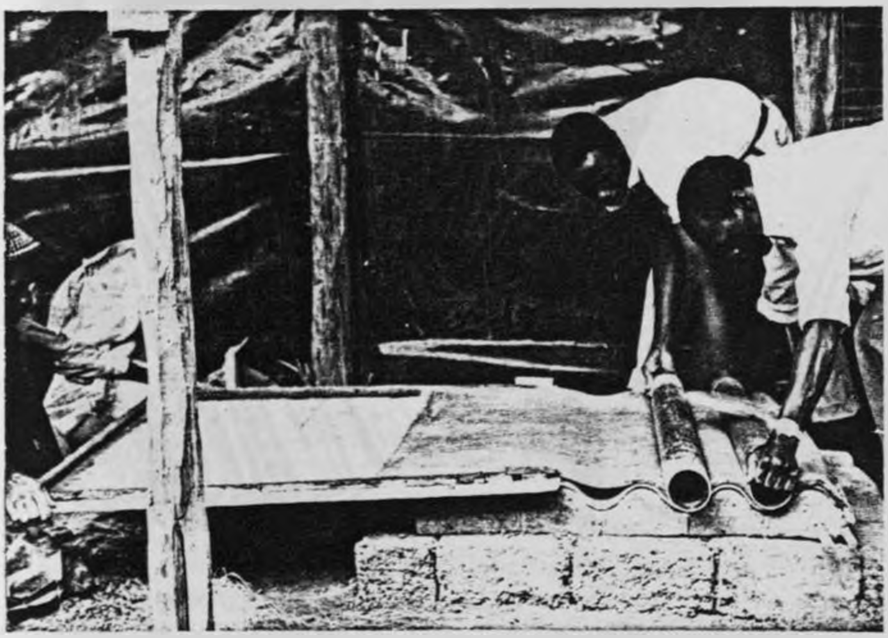


PLATE 3.10: PRESSING THE SISAL-CEMENT SHEET INTO THE CORRUGATIONS
Source: HRDU.

(vi) Covering the sheet with another piece of asbestos sheet of the same size and transferring it into a shed to cure and harden in that shape for the first two days.

(vii) Removing the sisal-cement sheet from between the two asbestos-cement sheets and soaking it in water in a curing tank for one week.

(viii) Removing the sisal-cement sheets from the curing tank and stacking them against a wall in bundles of not more than 10 sheets each and at an angle of 20^{o} or less to the vertical where they continue curing for another 20 days before using them. (Plate 3.11).

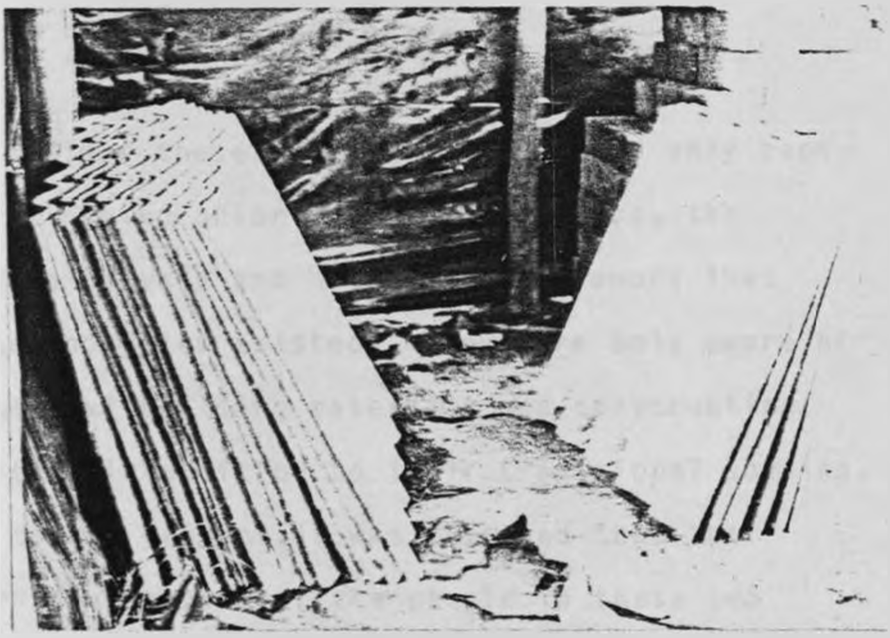


PLATE 3.11: STACKING OF SISAL-CEMENT SHEETS

Source: HRDU.

In summary, one can say that prior to the IRT project the Housing Research and Development Unit (HRDU) had satisfactorily tested the use of corrugated sisal-cement sheets and stabilized soil-cement blocks in the construction of a demonstration health clinic at Kabiro village, and so far these improved building materials have performed quite satisfactorily. However, there are still questions concerning the long-term durability of these materials, questions that will only be answered by the performance of the materials through time.

Introduction of the Technology in Bunyala and Mbita

Since these new technologies had only been tried in Kabiro prior to the IRT project, the people in Bunyala and Mbita were not aware that such technologies existed. They were only aware of conventional building materials and construction techniques in addition to their traditional housing. Prior to the project it was expected that the conservative nature of the people in these two areas might be a constraint to the success of the project. Even though the technology is quite simple, it was not known how readily the people would accept it. Generally, the people in Bunyala and Mbita see earth as being an inferior building material and consequently, there was initially some resistance to the use of stabilized soil-cement blocks for permanent house construction.

Rural House Improvement Loan Program

If the people in Bunyala and Mbita were to accept the technology, then in addition to providing a less expensive means of building teachers' houses, it also provides a viable alternative to individual rural families who are interested in improving their homes but do not have enough money to use conventional building materials. Such families would then be able to utilize the rural home improvement loans which are available from the National Housing Corporation (NHC). This program extends building loans to rural families with properly registered land ownership to enable them to build better and more permanent houses for themselves. However, the National Housing Corporation does not currently acknowledge that soil-cement blocks and sisal-cement roofing sheets are permanent building materials and consequently, they are reluctant to give rural home project. Even though the technology is quite simple, it was not known how readily the people would accept it. Generally, the people in Bunyala and Mbita see earth as being an inferior building material and consequently, there was initially some resistance to the use of stabilized soil-cement blocks for permanent house construction.

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Political Support for the New Technology

The problem of providing the teachers in Bunyala and Mbita with improved housing was a common topic of discussion at meetings of the SPA, and the parents made sure that the Members of Parliament (MPs) of the two constituencies were well aware of this problem. Consequently, both parents and MPs continued to look for alternative solutions to the problem.

In response to this problem the MPs began looking for funds which could be used by the local community to build teachers' houses. Prior to the start of the IRT project, it was thought that the provision of housing could be accomplished most successfully through the establishment of a Primary School Housing Co-operative Society (PSHCS) in each constituency which would be composed of teachers and parents from within the constituencies. In fact, the MPs saw the formation of a co-operative as providing a solution by which parents would no longer have to concern themselves with providing housing for teachers or even maintaining the houses.

The co-operative would fulfill this role.

Since the houses would be for teachers, it was thought that the Teachers Service Commission could pay monthly rent for the use of the houses directly to the housing co-operatives. The co-operatives would then use this money to build more houses. In the long run it was expected that the project would benefit all primary schools within the constituencies. In the future then, "harambee" would only be necessary for building classrooms.

Although the idea of a housing co-operative received support from the people in Nairobi who were planning the implementation of the IRT project, in practice most co-operatives in Bunyala and Mbita had been very unsuccessful and had developed a reputation among the local people as being a corrupt type of institution. Consequently, it was to be expected that both teachers and parents might be reluctant to join any type of co-operative. In fact, just prior to the start of the IRT project the main fishing co-operative in Mbita had been dissolved because of the mismanagement of funds.

It was through requests from the MPs for Hakati and Mbita constituencies that USAID agreed to provide the two constituencies with a grant of

$100,000 for the purpose of constructing improved teachers' housing. Based on the successful use of soil-cement blocks and sisal-cement roofing sheets at Kabiro in Nairobi, the MPs agreed to use the same low-cost technologies in building the teachers' houses. They were impressed with the demonstration unit both in terms of its high quality and low cost. The grant was given to HRDU who was to coordinate activities between the USAID Nairobi office and the local communities in the two constituencies.

In summary, one can say that the IRT project initially had strong political support in both constituencies. However, the co-operative was not seen by the people of Bunyala and Mbita as being an effective institution for coordinating the construction of teachers' houses.

Institutional Framework for Housing Co-operatives

Given the unsuccessful history of many co-operatives in the study area and elsewhere in Kenya, it is important to understand the framework that has been established at the national level to assist these co-operatives in successfully fulfilling their responsibilities to their members. At the national level there are three major institutions which are responsible for providing co-operatives with the technical, managerial, and financial assistance they need: the Ministry of Co-operative Development, the Co-operative Bank, and the National Co-operative Housing Union (NACHU). Special emphasis is given to the role played by these institutions in assisting housing co-operatives.

Ministry of Co-operative Development

The Ministry of Co-operative Development was first established in 1974 to coordinate registration, supervision, management, and education of co-operatives of all types. However, since the Ministry is responsible for all types of co-operatives, the services extended to housing co-operatives have been very inadequate up to this point in time. Although the Ministry has special sections for rendering services to certain types of co-operatives (e.g. Savings and Credit Unions), there is no such section for housing co-operatives. Consequently, people who have been assisting housing co-operatives in most cases know very little about housing development, especially housing finance.

In addition to lack of staff who are well informed about housing development, the Ministry has not been able to provide proper assistance on management issues nor has it been able to extend needed educational services adequately.[21] This was also true of the type of help offered to the housing co-operatives by the co-operative officers for Mbita and Hakati divisions. Most of the assistance provided was limited to activities concerned with the initial establishment of the co-operatives such as getting interim committee members elected, opening a bank account, recruiting members, and taking care of the two co-operatives' accounts.

The Co-operative Bank

Like the Ministry of Co-operative Development, the Co-operative Bank has also failed to be helpful to housing co-operatives. Although the Co-operative Bank was established in 1968 for the purpose of providing banking services to the co-operative movement, not many housing co-operatives have managed to secure loans from the Bank. In fact, by the end of 1983 only three housing co-operatives had actually received loans from the Bank to develop houses.[22] The main reason for this is that the mortgage section, which was first proposed in the late 1970s to assist housing co-operatives specifically, had not yet become operational at the beginning of 1985. However, once such a section becomes fully operational, then money earmarked for co-operative housing can be channelled through the Bank.[23]

National Co-operative Housing Union (NACHU)

Plans to establish a National Co-operative Housing Union (NACHU) were first discussed in the early 1970s. However, it was not until 1983 that NACHU finally became a reality. It was created for the purpose of establishing and developing an efficiently managed system of support to low-income groups organized as housing co-operatives. Presently, their target group consists of those households with an average monthly income of Kshs.1000.[24] Consequently, NACHU too will fail to reach a large percentage of low-income households. But at least its creation is a step in the right direction.

NACHU has been designed to provide low-income housing co-operatives with the following services: (1) development of educational programs to benefit members of housing co-operatives; (2) assistance in the registration process; (3) help in planning relevant housing projects that correspond to the needs and financial capacity of potential beneficiaries; (4) assistance in the preparation of site and house plans; (5) assistance in acquiring land, securing long-term finance, engaging contractors, and getting building plans approved; and (6) assistance with accounting procedures, auditing, collection and maintenance of resources, and organization of savings schemes.[25] Although NACHU is still in the process of beginning operations, it is expected that once it becomes fully operational it will be able to assist housing co-operatives, especially those for the low-income group, much more successfully than the Ministry of Co-operative Development has been able to in the past. During the 1984-88 Plan period the Government has committed itself to providing technical and financial assistance to NACHU until it becomes self-supporting.[26]

In summary one can say that the institutional framework set up at the national level to assist housing co-operatives is still in its formative stages and thus, the services extended to housing co-operatives up to this point in time have been very inadequate.

Summary

From the preceding discussion of the project setting one can identify several factors at the national and local levels which affected the implementation of the IRT project. These factors can be summarized as follows:

(1) the distances between the five project sites are significant, especially the 200 kilometer distance from Bunyala to Mbita; (2) the accessibility to these sites becomes extremely difficult during the heavy rains; (3) the climate of the study area will severely test the performance of the improved indigenous building materials which have been used in the project; (4) the design of the traditional Luhya and Luo house addresses itself directly to the climatic and economic characteristics of the study area; (5) most families in the study area are engaged in subsistence farming and thus, low household incomes limit people in the types of houses they can afford; (6) traditionally, house construction was typically done on a "harambee" (self-help) basis when the local people were properly informed ahead of time; (7) with the introduction of

new technologies in the furniture and building materials industries which emphasize rectangular shapes, the circular floor plan is becoming obsolete; (8) most rural people aspire to own a house built with conventional building materials; (9) the problem which gave rise to the IRT project was the need to provide teachers with housing that was low-cost, yet high in quality, and near the primary schools; (10) in the past School Parents Associations have been successful in mobilizing local communities to construct teachers' houses; (11) the technologies used in the IRT project had been satisfactorily tested by HRDU prior to the project; (12) prior to the project, people in the study area resisted the idea of using earth in conventional house construction because they saw it as being an inferior material; (13) the National Housing Corporation does not officially support the use of soil-cement blocks and sisal-cement roofing sheets as conventional building materials; (14) initially the project had strong political support in both constituencies; (15) because of the failure of other co-operatives in the study area, the local people did not see the housing co-operative as being an effective institution for coordinating the construction of teachers' houses; and

(16) the institutional framework set up at the national level to assist housing co-operatives has been inadequate up to this point in time.

Project Description

Having thus examined the project setting in terms of the national and local factors which affected the implementation of the IRT project, one can now look at how the project was intended to be implemented within the original project setting. The plan for implementation will be discussed in terms of the original project purpose, objectives, and strategies. Much of the information presented has been taken from the original Project Activity Paper which was prepared by USAID and HRDU prior to the start of the project.

Project Purposes

The primary purpose of the Improved Rural Technology project was to transfer appropriate low-income housing construction technology to rural communities by building demonstration housing units for teachers of government-assisted primary schools in the Bunyala and Mbita areas of Western and Nyanza Provinces of Kenya. A second purpose was to establish some means (in this case housing co-operatives) through which the technology transferred to the local community could be further replicated in the construction of more teachers' houses, other school buildings such as classrooms, residential houses for private individuals, rural clinics, community halls, commercial buildings, and other small one-storey structures.

Project Objectives

Although the project Activity Paper was not explicit, it seemed to imply that the achievement of the project purposes could be measured by the degree to which the following project objectives were successfully achieved. The first of these was to construct 12 demonstration housing units at a construction cost of approximately Kshs.48,000 per unit, which was 50% lower than the cost of a similar house built with conventional building materials and techniques. Maintenance cost was estimated to be Kshs.2000 per unit per year. And the 12 houses were to be completed within a time period of 48 weeks.

The second objective was to create employment and generate income for those who would be directly involved in the production of materials and construction of the housing units. It was anticipated that skilled workers who participated in the project would learn about the new technologies, improve their existing skills, and improve their economic welfare. In addition, it was expected that the local people who volunteered to perform unskilled tasks on a self-help basis would benefit indirectly by acquiring knowledge about the technology and construction techniques which would enable them to improve their own houses or produce better quality building materials or construct houses for richer families on a hired basis and thus generate additional income for themselves.

The third objective was that the project would directly benefit 12 teachers plus their families who would be accommodated in the demonstration houses and about 500 pupils who would receive better attention by the teachers when residing at school. The teachers would benefit in terms of reduced transport costs, improved housing conditions, and increased productivity in their teaching. The pupils would benefit in terms of improved examination performance resulting from more productive teaching and in terms of greater opportunities to be active in school activities such as debate, drama, and games since teachers living within the school compound would be more available to direct such activities. It was also thought that more qualified teachers would be attracted to the schools where staff houses were built with the improved indigenous building materials. The fourth project objective was to enable the local community and other schools around the area to use the same techniques to build better houses as and when they were able to afford them.

Project Strategies

Although not explicitly stated, the Project Activity Paper suggested several strategies through which the project purposes and objectives were to be achieved. These strategies can be discussed in light of the responsibilities of the three agencies involved in the project: the main financing agency (USAID), the technical agency (HRDU), and the implementing agency (the MPs, the School Parents Associations, the Primary School Housing Co-operative Societies, and the local people).

The Role of USAID

The finance for the project was to be provided through the combined efforts of USAID and the local community. However, the major source of finance (i.e. 74% of the total) for the project was to be provided by USAID in the form of a $100,000 grant which was to be used to pay for building materials, skilled labour, tools, equipment for the co-operatives, technical assistance, transportation and per diem for technical staff, and reproduction of drawings and reports. A second source of finance (i.e. 26% of the total) was to be provided by the local community in the form of land, self-help labour and on site service provision, and local project management. The planned financial contributions from USAID and the local community are presented in Table 3.1. In addition to providing finance, USAID was jointly responsible with HRDU for project monitoring.

The Role of HRDU

In addition to being responsible for coordinating activities between the USAID Nairobi office and the local communities, the Housing Research and Development Unit at the University of Nairobi was expected to play a major role in the design and planning of the project, the training of

		Planned July 1982 (US$)
	USAID Financial Inputs	
(i)	Materials, skilled labor, equipment, and tools for 12 housing units	60,000
(ii)	Equipment for 2 PSHCS, one in each constituency	4,500
(iii)	Technical supervision and sample testing by HRDU	10,000
(iv)	Transportation and per diem for technical staff, purchase of motor-bike, and site living expenses	14,500
(v)	Reproduction of drawings and reports	11,000
	Total USAID Contribution	100,000
	Local Community Contribution	
(i)	Land for development of 6 housing units in each constituency	18,000
(ii)	Self-help labor and on site service provision	12,000
(iii)	Local Project management inputs	5,000
	Total Local Contribution	.35,000

TABLE 3.1: PLANNED FINANCIAL CONTRIBUTIONS FROM USAID AND THE LOCAL COMMUNITY.

Source: USAID.

the local people, the supervision of the project, and the monitoring and evaluation of the project.

Planning and Design

In the design and planning phase of the project, HRDU was expected to carry out the following: (1) assist in the identification and selection of the sites; (2) prepare the required construction drawings including site plans, house type plans, and construction details and then explain them to the local people; (3) collect soil samples from the selected sites, prepare soil-cement sample blocks, test them, and work out the appropriate cement contents mix ratios to be used in block production on site; and (4) assist in identifying and purchasing the right equipment, tools and materials for the project. During this phase it was expected that HRDU would work in close collaboration with the SPAs in the two areas, thus involving the local people in decision-making to produce plans that were compatible with the living style, cultural, social and economic patterns of the local community.

Training

Since this project involved the use of materials and construction techniques that the local people were not familiar with, it was critical that HRDU provide instructions and demonstrations of techniques for producing most of the required building materials on site and for constructing the houses using these locally produced materials. The latter was to include demonstrations on the proper use of equipment, tools, and materials.

Supervision

The experimental nature of the project also required that HRDU closely supervise all aspects of project implementation. This task required HRDU to be responsible for the following: (1) to supervise and inspect all construction works on site; (2) to regularly check the materials produced on site to ensure that the required standards and quantity of the materials were maintained; (3) to arrange for monthly site meetings and prepare minutes thereof; and (4) to monitor the overall project management offered by the PSHCSs and SPAs to ensure that the projects' activities were carried out effectively. Since the $100,000 grant was given to HRDU on behalf of the School Parents Associations in Bunyala and Mbita, it was expected that HRDU would keep proper records of the projects' funds. HRDU was expected to provide supervision on a periodic basis. The day-to-day supervision of the sites was to be performed by a Peace Corps volunteer assigned to the project by USAID.

Monitoring and Evaluation

Since the purpose of the project was to transfer appropriate low-cost housing construction technology to rural communities for the purpose of replicating the project, it was important for HRDU to document the projects' activities through the preparation of project progress reports and a final project report which would be evaluative in nature. The findings could then be used to improve the future replication of the project.

The Role of the Local People

Prior to the start of house construction the strategy was to involve the MPs and the SPAs in introducing and explaining the projects' objectives and its usefulness to the local people in the two constituencies. Given this initial introduction the

MPs and SPAs would then work together with the local people to establish Primary School Housing Co-operative Societies (PSHCSs) in the two areas. After the housing co-operatives were formed, the Project Agreement between USAID and HRDU was to be signed and then project implementation was to begin. In fact, the need to have functional housing co-operatives at the local level was emphasized in the original Project Activity Paper.

Once the PSHCSs were formed in the two constituencies the SPAs would work together with them to carry out the following: (1) mobilize the local people to participate in the implementation of the project (i.e. construction of access roads, site works, production of materials on site by unskilled workers, and actual construction of the houses by a team of both skilled and unskilled workers. It was intended that unskilled tasks would be carried out by local people on a self-help basis); (2) select schools and specific sites near those schools where the demonstration houses would be developed; (3) participate in house plan design and formulation; (4) identify sources of indigenous building materials located near the selected sites; (5) provide water on site for construction works; and (6) take care of construction equipment, tools, and materials on site.

After the houses were fully completed it was expected that the PSHCSs would properly maintain the houses and collect rent (i.e. the housing allowance paid to teachers by the Government). The PSHCSs would then take responsibility for building more teachers' houses and other school buildings at other primary schools within the constituencies, utilizing the income generated through the collection of rent from teachers and membership dues from co-operative members.

Summary.

In summary one can say that the two major purposes of the IRT project were to transfer appropriate low-cost housing technology to rural communities and to establish some means through which the local communities could further replicate the technology. These project purposes were further defined by four, more precise project objectives.

The project strategies were described in terms of the responsibilities assigned to each of the agencies who were to be involved in project implementation, that is USAID, HRDU, and the local people. There are five strategies in particular that should be kept in mind when reading the next chapter about the evaluation of the IRT project. First, only one person was to be assigned to provide daily supervision at all five project sites. Second, housing co-operatives were to be established locally in Hakati and Mbita before the start of project implementation. Third, the SPAs in conjunction with the housing co-operatives were expected to mobilize the local people. Fourth, the people in Hakati and Mbita constituencies were expected to join the housing co-operatives. And fifth, unskilled tasks were to be performed by the local people on a self-help basis.

Having examined the environment in which the project was carried out (i.e. the project setting) and the way in which the various agencies were to work together to accomplish project objectives (i.e. the project description), one can now examine the degree to which the project effectively and efficiently achieved its planned objectives. Important aspects of project implementation will be highlighted in the evaluation of project effectiveness and efficiency in the next chapter.

NOTES

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Introduction

The purpose of this chapter is to present the findings from a case study of the Improved Rural Technology (IRT) project. This information is presented in two parts. The first part evaluates the degree to which the IRT project achieved its planned purposes and objectives. The second part of the chapter evaluates the efficiency of project implementation. Four key indicators of project efficiency are considered: speed of implementation, cost of building materials and labor, quality of the houses, and replicability of the project.

Evaluation of Project Effectiveness

The effectiveness of a project can be defined as a measure of the degree to which a project attains its objectives or as the degree to which an output, purpose, or goal target is achieved.[1] Consequently, given the project purposes as stated in the last chapter, this part of the evaluation seeks to answer two basic questions. The first concerns itself with the degree to which low-cost housing construction technologies were actually transferred to the rural communities in Bunyala and Mbita. The second concerns the degree to which some means has been established by which the technology transferred to the rural communities can be further replicated in the construction of more teachers' houses, classrooms, administrative blocks, residential houses for private individuals, rural clinics, commercial buildings, and other small one-storey structures.

According to the original Project Activity Paper prepared by USAID and HRDU prior to the start of the project in Western Kenya, the effectiveness with which the project purposes were carried out was to be assessed on the basis of several, more precise project objectives. The intent of this part of the evaluation is not to examine the efficiency with which the project objectives were implemented, but rather, the degree to which they were attained. The emphasis in this part is on end products, not the process. The next part of the evaluation will consider the efficiency of project implementation.

Units Completed, Cost, and Time

The first project objective was to construct twelve demonstration housing units at a construction cost of approximately Kshs.48,000 per unit and within a time period of 48 weeks. Because of numerous delays in project implementation, the period required to complete the IRT project was almost three times longer than originally anticipated. Instead of 48 weeks, it took two years and eight months to complete the project. Because of the increased length of the project and other unforeseen factors, the total cost of each housing unit rose sharply. Consequently, only 10 of the 12 housing units were completed despite the fact that the value of the American dollar increased by 54% during the project period.

As of the Project Assistance Completion Date (PACD) of October 31, 1985 when HRDU officially transferred control of the IRT project to the registered housing co-operatives, ten three-roomed housing units had been completed to a reasonable degree. Each of the five project sites has two teachers' houses. Although the arrangement of houses at each site varies from one primary school to the next depending on the physical characteristics of each site; one of the more common arrangements, i.e. the one used at Ruambwa and Makunda primary schools, is shown in Figure 4.1.

It was intended that each house would be rented to two teachers. One teacher and his family would occupy two rooms, and the other would occupy the third room. Consequently, each housing unit has two kitchens, two bathrooms and two ventilated improved pit latrines.

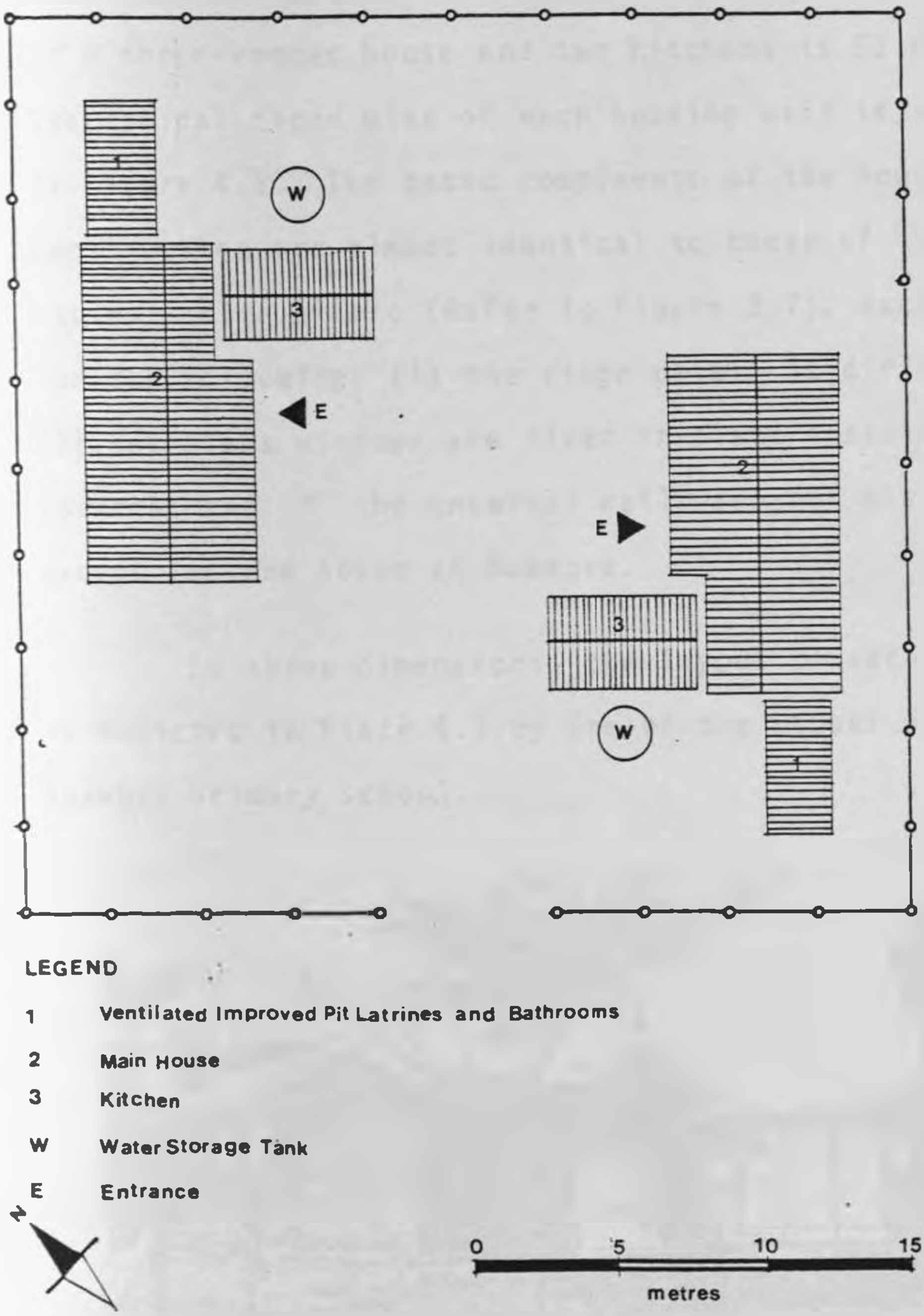


FIGURE 4.1: TYPICAL SITE PLAN

Each set of two houses also has a ferro-cement water tank for rain water collection. The total floor area of a three-roomed house and two kitchens is 53 m^2. The typical floor plan of each housing unit is shown in Figure 4.2. The basic components of the house construction are almost identical to those of the Kabiro health clinic (Refer to Figure 3.7), except for the following: (1) the ridge detail is different; (2) the glass windows are fixed in place instead of louvred; and (3) the internal walls are not plastered except for one house at Ruambwa.

In three dimensions, the layout of each house is depicted in Plate 4.1 by one of the houses at Ruambwa primary school.

PLATE 4.1: IMPROVED TEACHERS' HOUSE AT RUAMBWA PRIMARY SCHOOL

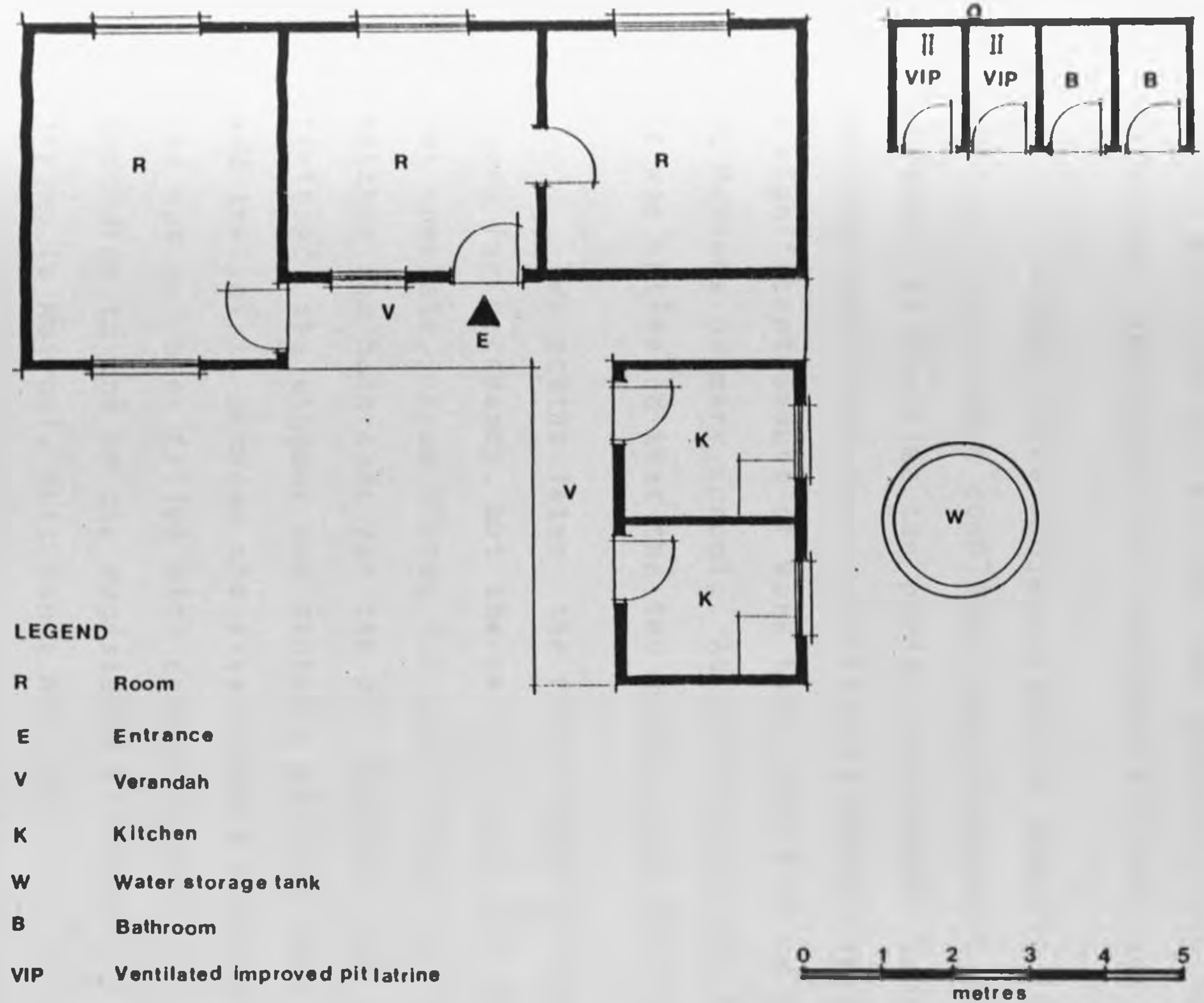


FIGURE 4.2: TYPICAL FLOOR PLAN OF IRT HOUSING UNIT

Source: Housing Research and Development Unit, 1982.

In Plate 4.1 the three-roomed house is on the left. The kitchens are projecting out from the main house and are in the center of the plate. And on the right behind the tree one can see the water storage tank, bathrooms, and ventilated improved pit latrines.

At the three project sites in Bunyala location all six houses were completed to a reasonable degree. However, at the time the project was handed over to the registered housing co-operatives there was still a significant amount of work that needed to be completed at Makunda primary school. At the time of the transfer it was estimated that the two houses were 90% complete.

Two months later the first house was nearly ready for occupancy, but the second house was still not complete. From Plates 4.2 and 4.3 one can see that neither the bathrooms nor the pit latrines had been finished, the windows and shutters had not been fixed, and the joints between the sisal-cement roofing sheets had not yet been filled with cement mortar. According to one of the registered co-operative officials living in Nairobi, this house had not yet been finished by June of 1986, which was seven months after the PACD. He also mentioned that the foundations of the bathrooms and pit latrines had fallen in during the extraordinarily heavy rains in April and May. To a certain degree the failure of the co-operative to complete both houses in

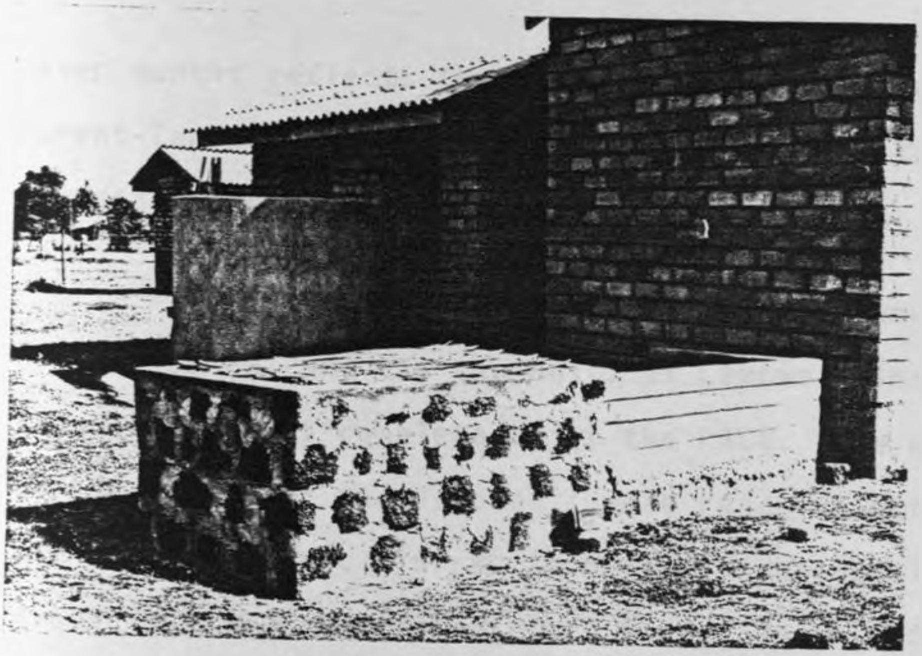


PLATE 4.2: INCOMPLETE BATHROOMS, PIT LATRINES, AND WINDOWS

PLATE 4.3: JOINTS BETWEEN SISAL-CEMENT ROOFING SHEETS NOT YET FILLED WITH CEMENT MORTAR

seven months reflects the limited ability of the Bunyala Parent-Teachers' Housing Co-operative Society to coordinate additional construction activities.

In Mbita division the two units at Nyamuga primary school and the two units at Lambwe primary school were 100% complete as of the PACD. The walls of the houses at these schools were rendered externally with a sand-cement slurry to provide additional protection from the rain (Plate 4.4). Because of the shortage of funds resulting from the delay of the project, the construction of the two housing units at the third site in Mbita division, God Oloo primary school, was never started.

Employment and Income Generation

The second project objective was to create employment and generate income for those who would be directly involved in the production of building materials and construction of the housing units. The attainment of this objective also helps one to assess the degree to which the original project purpose of transferring low-cost housing construction technologies to the people in Bunyala and Mbita was achieved. The degree to which this objective and the original project purpose were achieved can be assessed in light of the opportunities

PLATE 4.4: IMPROVED TEACHERS' HOUSE AT NYAMUGA PRIMARY SCHOOL

provided for skilled workers and unskilled workers.

Skilled Workers

It was anticipated that skilled laborers (i.e. masons, carpenters, and painters) who participated in the project would learn about the new technologies, improve their existing skills, and improve their economic welfare. In terms of learning about the new technologies, six skilled workers, three from Bunyala and three others from Mbita, were sent to Kabiro village in Nairobi in March of 1983 for a period of three weeks to learn how to make sisal-cement roofing sheets and soil-cement blocks on site with locally available materials. All of these men had received prior training as masons, and consequently, the additional training received at Kabiro was concerned primarily with the production and use of these locally-produced building materials.

The purpose of this training was to equip them with the skills they needed to serve as project foremen at their respective sites. During the course of project implementation, the trained artisans were expected to teach other local masons how to use the new technologies. As a result of this project there are now 12 masons in Bunyala and Mbita who have learned how to produce and use the soil-cement blocks and sisal-cement roofing sheets.

It is also interesting to note that the man who conducted the practical component of the training course at Kabiro was not from HRDU, but was simply a local resident who had been trained during the construction of the initial demonstration unit at Kabiro. Given the high quality of the houses built in Bunyala and Mbita, one can conclude that the method of training instituted by HRDU has been quite successful.

In terms of improving their existing skills, nine masons and six carpenters gained enough additional work experience to sit for the Government Trade Tests in their respective fields. In terms of improving their economic welfare, the skilled laborers were paid a total of Kshs.213,000 in wages during the course of the project. But in addition to the monetary benefit, they also learned new skills concerning the production and use of improved indigenous building materials, skills which can be utilized in the future to generate additional income for themselves and provide themselves with improved housing.

Unskilled Workers

Since unskilled tasks such as making sisal-cement roofing sheets and soil-cement blocks and assisting skilled laborers in house construction were to be carried out by the local people on a self-help basis, it was expected that they would only benefit indirectly by acquiring knowledge about the technology and construction techniques which they could then use to improve their own houses or produce better quality building materials or construct houses for richer families on a hired basis and thus generate income for themselves. However, since the local people were reluctant to perform these tasks on a self-help basis, officials from USAID decided that in order to get unskilled laborers to start working on a consistent basis they would have to be paid a small honorarium for the work they did. Initially, the honorarium was Kshs.7 per day, and later it was raised to Kshs.10 per day.

As a result of this change in the original project objective the unskilled workers not only learned about the new technologies but were also paid nearly Kshs.186,500 in wages during the last 17 months of the project. In summary one can say that the original project objective of creating employment and generating income for those directly involved in the project was carried out to an even greater extent than had initially been planned. Because of the decision to pay unskilled workers for their efforts, both skilled and unskilled benefitted in terms of employment, increased incomes, and acquisition of skills which can be utilized in the future to generate additional income for themselves and improve the housing conditions in the study area.

A summary of the number and types of skilled and unskilled workers employed during the course of the project is presented in Table 4.1. However, in terms of unskilled workers, only those who were involved in sisal-cement sheet production and soil-cement block production are indicated.

Location	Skilled Workers		Unskilled Workers	
	Masons	Carpenters	Sisal-cement Sheet Production	Soil-cement Block Production
Bunyala	6	4	10	24
Mbita	6	4	8	20

TABLE 4.1: EMPLOYMENT OF SKILLED AND UNSKILLED WORKERS

Source: Field Study.

From the table one can conclude that the original project purpose of transferring low-cost housing construction technologies to the people of Bunyala and Mbita has been achieved. In Bunyala more than 40 people are now familiar with these technologies, and in Mbita the number is also more than 40. Consequently, the technical skills necessary for replicating the technology are already present in the two constituencies.

Accessibility to the Target Population

The third objective was that the project would directly benefit twelve teachers and their families who would be accommodated in the demonstration houses. Although not explicitly stated, this objective implies first that the target population was primary school teachers and second, that they would be able to afford to live in the demonstration houses.

The nature of the target population makes this project unique in two ways. First, primary school teachers have a much higher average income than the average household in Bunyala or Mbita. Consequently, they can afford to pay more for housing than the average rural family. Second, since teachers are transferred from one school to another on a rather frequent basis, it was important that the houses be built for rental purposes.

If the houses were accessible to primary school teachers, it was expected that they would benefit in terms of reduced transport costs to and from school, increased productivity in teaching, and improved housing conditions. Second, it was thought that improved housing for teachers near the primary schools would also benefit about 500 pupils who would receive better attention from the teachers residing in the demonstration houses. And third, it was thought that more qualified teachers would be attracted to the primary schools where staff houses were built with improved indigenous building materials.

Of the ten houses which were handed over to the housing co-operatives in October of 1985, five houses in Bunyala and two houses in Mbita are presently occupied (May of 1986). In Bunyala, the four houses at Ruambwa and Budalangi are occupied by primary school teachers whereas the only house completed at Makunda is occupied by teachers from Makunda secondary school.

All of these teachers are highly qualified (P1s&S1s) and consequently receive a house allowance of at least Kshs.600 per month from the Government. Since the housing co-operative in Bunyala is currently charging Kshs.300 per month for two rooms, Kshs.200

per month for one room, and Kshs.500 per month for all three rooms; all of the teachers who are presently living in the houses can actually afford to rent all three rooms. However, it is only at Ruambwa where one house is fully occupied by just one teacher and her family. Even teachers with lower qualifications such as P2s and P3s can afford to rent two rooms since they receive a house allowance of Kshs.350 and above each month. Consequently, one can conclude that most primary school teachers can afford to rent the IRT housing units. It is interesting to note that even though the project was completed more than two years later than had initially been expected, the houses are still affordable.

At Lambwe primary school in Mbita division both houses are occupied, but neither is occupied by primary school teachers. A pastor of one of the local churches occupies three rooms of one house, and the second is occupied by people who work for the Lake Basin Development Authority. Although the primary school teachers can afford to pay the monthly rent of Kshs.400 being charged by the housing co-operative for three rooms, they choose to live in the traditional houses that were built by parents and children on a self-help basis.

The houses are located within the school compound and have an earth floor, mud-and-wattle walls, and a roof of iron sheets (Refer to Plate 3.2). The reason that teachers prefer to live in houses of such low quality is because they are currently receiving a house allowance from the Government in addition to receiving a house in which to live. Since they already have a house, they choose to spend the money received from the Government in some other way. Consequently, there is little incentive for them to live in the new houses.

At Nyamuga primary school in Mbita division both houses remain unoccupied because of a serious conflict between members of the Jonyoul Housing Co-operative Society which resulted from the fact that some local leaders provided parents at Nyamuga primary school with inaccurate information about the ownership of the houses.

When the IRT project was first started, two meetings were held in which the objectives of the project were presented to the parents of Nyamuga and Lambwe primary schools. During those meetings HRDU and the Member of Parliament for Mbita constituency clearly communicated what the objectives were,including the fact that all four houses would belong to the housing co-operative when they were completed. However, not many people were able to attend the two initial meetings. In fact, besides the school committee members, few others attended. As the project progressed, those who missed the first two meetings were persuaded by local leaders to believe that the houses at Nyamuga primary school were owned by the school and not the co-operative. This confusion has greatly limited the degree to which the Jonyoul Housing Co-operative Society can carry out its responsibilities.

Initially, the people in Mbita were very interested in the project, but now the confusion is destroying their morale. Since parents at Nyamuga want the houses to be owned by the primary school and not the co-operative, parents at the other schools in the constituency do not see any hope of benefitting from the project and are no longer as interested in the project as they once were. It appears to them as though the IRT project will only benefit two of the seven locations in the constituency, that is Lambwe and Rusinga Island.

In an attempt to resolve the conflict, the District Officer for Mbita division is planning to call a meeting in which he will explain to the parents at Nyamuga primary school that the houses belong to the housing co-operative. Consequently, there is still hope that the conflict will be resolved and that the co-operative will be able to function in the way it was originally intended.

From the preceding discussion one can conclude that primary school teachers in Bunyala and Mbita can afford to live in the IRT housing units. Hence, one can now assess the degree to which the teachers have actually benefitted in terms of reduced transport costs to and from school, increased productivity in teaching, and improved housing conditions. However, because it is only in Bunyala that the houses are actually occupied by teachers, the following discussion does not include the occupants of the two houses at Lambwe primary school.

Reduced Transport Costs

In terms of reduced transport costs to and from school, the benefit to teachers in monetary terms has been negligible. Even though the distance from home to school is large, most teachers choose to walk or ride a bicycle to school, options which are essentially free except for the cost of the bicycle. However, in most cases a primary school teacher will own a bicycle anyway for other purposes such as shopping. Consequently, the fact that teachers living in the demonstration houses now live very near the school compound has no effect on transport costs from a monetary point of view. However, the fact that the distance to school has been considerably shortened reduces the amount of time these teachers spend commuting to and from school every day. Thus, in terms of the opportunity cost associated with commuting, there is a tremendous savings daily.

Increased Productivity

Because the teachers who are living in the demonstration houses spend less time travelling to and from school, they now have more time to prepare lessons, mark assignments, supervise other school activities, and they are not physically tired when they arrive at school each morning. Consequently, they are able to teach more effectively and it is in this respect that their pupils benefit.

Improved Housing Conditions

In terms of improved housing conditions, the responses of the teachers depended on the type of house in which they had lived prior to their appointment to Bunyala. For those teachers who had previously been teaching in urban areas and living in houses built with conventional building materials such as cement, concrete blocks, tiles, and iron sheets; they indicated that their housing conditions have not changed significantly. But for those teachers who had previously been teaching in Bunyala or other rural areas and living in traditional houses with earth floors, mud-and-wattle walls, and thatch or iron sheet roofs; they indicated that their housing conditions had improved considerably. However, even those who had previously been living in urban areas agreed that it was very rare to find houses of such high quality at rural primary schools. Generally, one can say that the overall quality of the IRT housing units is much higher than the typical teachers' houses in Bunyala.

Attraction of More Qualified Teachers

In terms of attracting more qualified teachers to primary schools where staff houses were built with improved indigenous building materials, the teachers interviewed indicated that the main reason why they were teaching at Ruambwa, Budalangi, and Makunda primary schools was because they had been posted there by the Teachers' Service Commission. However, when they arrived, they were very pleased to see the high quality of the houses in which they were to live.

Replication

The final project objective was to enable the local communities in Bunyala and Mbita and other schools in these areas to use the same building materials and construction techniques to build more teachers' houses, other school buildings such as classrooms, residential houses for private individuals, rural clinics, community halls, commercial buildings, and other small one-storey structures. This objective also addresses itself to the original project purpose of establishing a mechanism through which the technology can be further replicated. The best indicator of the degree to which this objective has been achieved is whether or not the technologies have actually been replicated in the provision of shelter and other community facilities within the two constituencies.

Although HRDU officially transferred responsibility for the teachers' houses to the housing co-operatives in Bunyala and Mbita in October of 1985, the co-operatives had not replicated the technologies in any way by June of 1986. In fact, the Bunyala Parent Teachers' Housing Co-operative was still struggling to complete one of the houses at Makunda primary school, a house that had been 90% complete seven months earlier when the project was officially handed over to the co-operative.

Private individuals have been somewhat more successful in replicating the technologies. In Bunyala one private individual has already completed a house for himself using soil-cement blocks (Plate 4.5). In fact, he hired many of the skilled and unskilled workers who had built the houses at Ruambwa and Budalangi primary schools. Originally he intended to use murram stone to construct the walls, but when it was not readily available, he decided to use the soil-cement blocks. He too had been impressed by the quality of the houses at Ruambwa and Budalangi. However, since he was not limited financially, he chose to use clay tiles as a roofing material instead of the sisal-cement sheets.

Second, the MP for the constituency, who is also a long standing property developer, has started the construction of a 40-unit housing project near Hakati town. Because the progress of the project is slow and because murram stone is available near the site, he has chosen to use murram stone instead of the soil-cement blocks for wall construction. However, he has indicated that he intends to use the sisal-cement sheets as a roofing material.

Thus, one can say that the second project purpose of establishing some mechanism through which the technology can be further replicated has been partially achieved. Although the housing co-operatives had not yet replicated the technology in any way by June of 1986, there are two private individuals in Bunyala who have already used soil-cement blocks and sisal-cement roofing sheets in further construction activities.

PLATE 4.5: HOUSE OF A PRIVATE INDIVIDUAL IN BUNYALA - USE OF SOIL-CEMENT BLOCKS AS A WALL MATERIAL

Evaluation of the Efficiency of Project Implementation

Efficiency can be defined as a measure of the degree to which a project succeeds in maximizing its beneficial results at the least cost.[2] Consequently, the intent of this part of the evaluation is to identify possible areas where project implementation can be improved. The emphasis in this part of the evaluation is on process, not end products.

Since the major hypothesis of this study from the very beginning has been that the use of appropriate technologies and community participation can significantly lower the costs of house construction to a more affordable level, this part of the evaluation will focus primarily on these two project components, that is the technology and community participation. The emphasis on these components is in light of the fact that together they account for almost 82% of the total cost of a house.

In terms of the technology aspect of the IRT project (refer to definition of "appropriate technology" in Chapter One), emphasis is on the degree to which the production and use of improved indigenous building materials such as soil-cement blocks and sisal-cement roofing sheets affected the efficiency of project implementation.

In terms of the community participation aspect of the project (refer to definition of "community participation" in Chapter One); the main emphasis is on the role that local labor, i.e. both skilled and unskilled workers, played in project implementation. However, to some degree the evaluation also examines the role played by the housing co-operatives, SPAs, HRDU, and USAID in the implementation process. By utilizing skilled and unskilled workers already present in Bunyala and Mbita it was expected that the added costs associated with the formal contractor-built method of construction such as profits, overheads, and servicing contracts would be eliminated.

In order to assess the degree to which the technology and community participation components of the IRT project have affected the efficient implementation of the project, four key indicators of efficiency will be considered: speed of implementation, cost of building materials and labor, quality of the houses, and replicability of the project. At this point it is important to note that trade-offs may have to be made among the above indicators in the interest of efficient resource use or the achievement of overall project goals. For example, higher quality of house construction may result in both higher costs and a slower speed of implementation.

Speed of Implementation

Since undue delays in implementation can seriously affect costs and accessibility to target groups, the speed of project implementation is a critical indicator of project efficiency. Given that the IRT project took nearly two years longer than had originally been planned, a consideration of this indicator will help to identify the degree to which the technology and community participation aspects of the project delayed its completion.

Technology

To some degree the speed of implementation was affected by the technology which was used in the IRT project. For example, there were times when the "Brepak" machine broke down and had to be repaired. In fact, one of the project supervisors estimated that the machine broke down at least once for every 1000 soil-cement blocks produced, and there were so many problems with the hydraulic component of the machine that the project supervisor finally decided to stop using it. Consequently, the blocks produced at Makunda, Budalangi, and Lambwe were compacted without the use of the hydraulic component and thus required that a higher percentage of cement be added to the soil at these sites to ensure that the blocks produced would perform satisfactorily. In most cases though, the "Brepak" machine was repaired in one or two days, and consequently, delays resulting from the breakdowns were minimal.

Second, although the use of this technology requires far less cement than most conventional technologies, it still relies on the use of cement. In some instances during the IRT project the supply of materials was not regular due to contractual problems and occasional shortages of cement and timber. In March of 1985 work had to be suspended at all five project sites for nearly one month while new bids for cement and timber were issued and two new suppliers were chosen, one for Bunyala and one for Mbita.

The supply of materials was also affected by the fact that some project sites; especially Makunda, Nyamuga, and Lambwe; became inaccessible during the rainy season. Accessibility to these three primary schools was especially difficult during April and May of 1985.

Third, since the building materials were produced on site, the production of soil-cement blocks at each site depended on the availability of the "Brepak" machine. There were five project sites, but only three "Brepak" machines. Thus, the production of blocks at Budalangi and Lambwe did not begin until the required blocks had been produced for the houses at Ruambwa and Nyamuga primary schools. The shortage of machines would have resulted in serious delays if block production had begun simultaneously at all five sites. However, since construction activities were staggered at the five sites, the number of machines did not significantly delay the project.

There was also one other instance where the production of materials on site delayed the project slightly. At Budalangi the roofing of one house was delayed for one week while the carpenter waited for the sisal-cement roofing sheets to cure fully.

In reference to the delays associated with this technology the project supervisor said that most of them can be held to a minimum through proper planning. For example, soil-cement blocks can be produced during site preparation, the pouring of the foundation, and the laying of the floor slab; and sisal-cement sheets can be produced while the walls are being built. It was only the one to two month delay resulting from the inadequate supply of cement and timber that substantially affected the speed of project implementation. But even this delay was not entirely the fault of the technology. Rather, it was as a result of the retendering process and the inaccessibility of the sites during the rainy season.

Community Participation

Although the use of soil-cement blocks and sisal-cement roofing sheets delayed the project completion to a certain degree, the major reason for the two-year delay can be attributed to several other factors relating to the community participation aspect of the project. Although it was originally expected that members of the local community in Bunyala and Mbita would carry out unskilled tasks such as production of building materials and supply of water on a self-help basis, it proved very difficult to mobilize the people to do so. This was especially true during the first 16 months of the project and was the result of several factors, some of which were uncontrollable.

First, when physical implementation of the project was supposed to start in February of 1983, most of the people in Kenya including those in Bunyala and Mbita were suffering through a prolonged drought. By the end of 1984 the drought had resulted in a severe famine. In fact, in November of 1984 the trucks which had been transporting cement from the factories to the depots in Kisumu were instructed to assist in the delivery of famine relief food stuff to the affected areas. The fact that no cement was transported to any of the five project sites during that month delayed the project by one month.

Since people in Bunyala and Mbita needed money to purchase food stuffs, men could not volunteer to carry out unskilled tasks for no monetary gain. It was more important for them to find some way to feed their families. Consequently, the provision of self-help labor by the local people in Bunyala and Mbita was extremely erratic during the first 16 months of the project.

It was common for a person from the local community to pass by the site, stop and work for three or four hours, and then go back home to work in the garden or to pursue some other type of wage employment. Such a person might not return to the site for another week or two. Such a rapid turnover of people at the project sites made it difficult for the site foremen to properly train anyone in the production of soil-cement blocks and sisal-cement sheets. In a project like this where unskilled workers are taught how to produce building materials on site, it is necessary for those learning the techniques to be available on a daily basis. Otherwise, the project will be delayed.

Second, work on the project had to be stopped during October of 1983 due to Parliamentary General

Elections. This was primarily as a result of the fact that the foremen at each of the project sites were strong supporters of the candidates and thus were actively involved in the campaign. At Mbita, where a new Member of Parliament was elected, work was further delayed due to differences among society members. The supporters of the new MP did not want the IRT project to be successful because it had been initiated by the opposing candidate. Consequently, after the elections the project had problems gaining political support.

In addition to these two uncontrollable factors, i.e. the famine and the timing of the Parliamentary General Elections, there were several other factors which made it difficult to mobilize unskilled laborers to work on a self-help basis. First, during the course of the project the registered housing co-operatives never actually got set up locally in the two constituencies. Thus, they were not able to take an active role in project implementation and management.

In the original Project Agreement between USAID and HRDU the housing co-operative was identified as a vital element in the project's success. As a result, prior to disbursement of grant funds, HRDU was required to submit to USAID satisfactory documentary evidence indicating that a housing co-operative had been formed for each of the two constituencies.

To speed up the process of registering the two housing co-operatives with the Ministry of Co-operative Development, the Members of Parliament for the constituencies looked for co-operative officials who were Nairobi residents but still had family ties in Bunyala and Mbita. Thus, although the goal was that the housing co-operatives and their registered officials would be located in Bunyala and Mbita, in reality the officials were initially Nairobi-based and actually remained so throughout the project.

However, there were some attempts to operationalize the co-operatives at the local level. Since the registered officials were based in Nairobi, they decided to appoint some contact officials in each constituency who could coordinate co-operative activities at the local level. This was done during the early stages of the project and they remained contact officials throughout, but any decisions they made had to be approved by the registered officials in Nairobi.

In spite of the fact that these contact officials existed at the local level, the housing co-operatives still failed to effectively carry out the responsibilities assigned to them in the Project Activity Paper. Consequently, the main organizations responsible for mobilizing people at the local level to participate in project implementation did not set up operations in Bunyala and Mbita during the course of the project.

By June of 1986, seven months after HRDU officially transferred control of the project to the registered housing co-operatives, the co-operatives were still trying to transfer their operations to Bunyala and Mbita. However, the co-operative in Mbita had succeeded in transferring its bank account from Nairobi to a local bank in Homa Bay, and the co-operative in Bunyala was in the process of organizing elections for new co-operative officials. After the elections it was expected that the co-operative would be able to set up its operations in Bunyala.

Second, since the housing co-operatives never became operational at the local level, the responsibility to mobilize the people to provide self-help labor fell upon the SPA and other local leaders. However, some of the local leaders never understood the purpose of the project and thus were not able to clearly explain the project objectives to the people, especially concerning the provision of self-help labor and the ownership of the houses. It was only at the Ruambwa and Lambwe sites that the SPAs were somewhat effective in mobilizing the people to perform unskilled tasks such as making blocks and supplying water on a self-help basis.

Third, even if the housing co-operatives had been operational in the local context from the very beginning of the project, it is likely that they would not have been very effective in carrying out their responsibilities since neither the registered officials nor the contact officials of the two co-operatives were ever given any training in how to manage a housing project. This appears to have been a serious omission in the original project design because the existing housing co-operatives are still struggling to further replicate the technologies.

Although the failure of the local people in Bunyala and Mbita to provide unskilled labor on a self-help basis was the main reason for the slow implementation of the project, there were others. First, during most of the project one person was responsible for providing daily supervision at all five sites. Due to long distances between the sites (over 200 km from Bunyala to Mbita), adequate supervision could not be guaranteed.

Every month the project supervisor had to perform the following tasks: (1) travel to each of the project sites to inspect the work being done, (2) ensure that each site had the necessary building materials, (3) pay wages to the workers, (4) ensure that the required artisans were available on site to carry out the next month's work, (5) take care of the project accounts, and then (6) travel to Nairobi to account for expenditures incurred during the month.

Because of these numerous responsibilities, the long distance between sites, and the fact that the project supervisor was travelling by public means most of the time; he was only able to spend two days at each site each month. Consequently, it was nearly impossible for him to ensure that those employed at each site were working when they were supposed to be.

Second, the project representative from USAID estimated that the IRT project was delayed for three to four months due to cash-flow problems from USAID to HRDU. The delays resulted primarily from the failure of USAID to process the documents promptly. But in most cases, these delays were simply a result of the normally lengthy process of accounting for past expenditure and approving new disbursements.

Since the next disbursement of funds to HRDU could not be made until the previous month's expenditure had been accounted for, the project supervisor could not collect the disbursement for the next month at the same time he was accounting for expenditure incurred during the past month. For example, if he accounted for funds spent during the month of April on May 1st, he could not collect the disbursement for May until June 1st when he was accounting for expenditure incurred during the month of May.

Physical implementation of the project commenced in February of 1983. However, the first disbursement of funds from USAID did not occur until April of 1983. Because the housing co-operatives were not functional at that time and because HRDU had not yet received the first disbursement from USAID, very little was accomplished during the first two months of the project.

A second major delay in the disbursement of funds to HRDU occurred in January and February of 1985 and was primarily as a result of administrative delays at USAID involving the normal accounting procedure. Although the work did not come to a complete halt, its progress was substantially slowed down.

Third, because of the poor storage of materials, more than 6000 soil-cement blocks at Makunda, Ruambwa, and Nyamuga primary schools were damaged by rain and could not be used. It took approximately 60 working days for a team of three men to produce that many soil-cement blocks. Hence, block production was delayed by 60 days due to the careless storage of these soil-cement blocks.

Fourth, although minimal, the unavailability of skilled artisans, especially carpenters and glaziers when needed, also delayed project implementation to a small extent.

Although there were numerous delays throughout the course of the project, the slowest progress was from February of 1983 to June of 1984. It was during this time that the local people were reluctant to contribute labor freely. In fact, by June of 1984 only the two houses at Ruambwa had been started. In the first house, the floor slab had just been poured, and in the second, foundation excavation had just begun. The main reason that house construction started at Ruambwa was because the project supervisor, who at that time was the Peace Corps volunteer, was living in a house that was less than 100 meters from the construction site. Consequently, it was easier for him to closely supervise construction activities at that site.

In June of 1984 the contract of the Peace Corps volunteer expired and he had to return to the United States. Consequently, HRDU stationed a project supervisor on site. It was at this same time that the decision was made to start paying unskilled workers a small honorarium for their efforts. These two changes had a significant impact on the speed of implementation. By January of 1985 all ten houses had been started. In March of 1985 a second project supervisor from HRDU was assigned to the two sites in Mbita division. With project supervisors stationed in both Bunyala and Mbita, the distance between sites was no longer such a problem and the speed of implementation increased substantially. There were still some delays, but by October of 1985 all ten houses were more or less complete and the project was handed over to the housing co-operatives in the two constituencies.

Summary

In summary one can say that it was not the technology but the community participation aspects of the IRT project that caused the major delays in project implementation. In fact, the major reason for the minimal progress during the first 16 months can be directly attributed to the reluctance of the local community to provide unskilled labor on a self-help basis. The people never identified with the project as something they were doing for themselves. Rather, they saw it as something that was being done for them and consequently, they expected to be paid for the work they did. After the decision was made to pay unskilled workers the speed of project implementation increased substantially.

Other reasons for slow project implementation included the following: the timing of the drought and Parliamentary General Elections, the failure of the local housing co-operatives to take an active role in project implementation and management, inadequate on site supervision, cash-flow problems, delays in the supply of materials resulting from the retendering process and the inaccessibility of some sites during the rainy season, loss of building materials due to damage by rain, and occasional unavailability of skilled artisans when they were needed.

Cost

Project efficiency must also be defined in terms of cost. In fact, one of the major objectives of the IRT project was to introduce a technology and a method of house construction which would provide teachers with a low cost, but high quality alternative to conventional housing. A consideration of this indicator will identify the degree to which the technology and community participation aspects of the project were actually able to lower the cost of house construction.

Planned vs. Actual Project Expenditure

In evaluating the degree to which project objectives were achieved it was mentioned that a number of unexpected factors caused the total cost of each housing unit to rise above the amount originally anticipated. And as a result, only 10 of the 12 units were actually completed. Table 4.2 presents a comparison of the planned vs. the actual project expenditure on building materials, skilled labor, and unskilled labor (i.e. the total expenditure on the technology and community participation aspects of the IRT project). The actual amount spent on building materials includes all materials used in the project including those used in the construction of the houses, kitchens, ventilated improved pit latrines, bathrooms, ferro-cement water storage tanks, curing tanks for the sisal-cement roofing sheets, shelters for protecting the soil-cement blocks, and even the fences surrounding the housing units at each project site.

	Planned (July 1982)	Actual (October 1985)
Number of Housing Units	12	10
Expenditure on Materials (Kshs.)	538,720	628,000
Expenditure on Skilled labor (Kshs.)	47,080	213,000
Expenditure on Unskilled labor (Kshs.)	0	186,500
Cost per Unit (Kshs.) Materials only	44,893	62,819
Cost per Unit (Kshs.) Materials and Skilled labor	48,817	84,121
Cost per Unit (Kshs.) Materials, Skilled, and Unskilled labor	48,817	102,760

TABLE 4.2: PLANNED vs. ACTUAL EXPENDITURE ON THE IRT PROJECT.

Source: IRT Project Files.

The figures for planned expenditure were obtained from the original Project Activity Paper prepared by USAID and HRDU in 1982, and consequently, the amounts quoted were based on the costs for labor and materials as they were in July of 1982. The figures for actual expenditure were calculated on the basis of monthly progress reports prepared by the project supervisors. The figures quoted are the total amounts that had been spent by the time the project was officially handed over to the local housing co-operatives in October of 1985.

However, it should be noted that the figures quoted for the actual expenditure may not be totally accurate since the financial records kept during the first 16 months of the project were not complete. But it should also be noted that nearly 81% of the total expenditure on materials and labor was incurred after the first 16 months when accurate monthly records were being kept by the project supervisors. Consequently, the figures presented in Table 4.2 for the actual expenditure are relatively close approximations of the true values.

From Table 4.2 one can see that the actual expenditure on building materials, skilled labor, and unskilled labor exceeded the planned expenditure in all three cases. The actual expenditure on building materials exceeded the planned expenditure by Kshs. 89,474 or 16.6%. Although the amount spent on materials was only slightly higher than had been expected, the amount spent on skilled labor exceeded the planned amount by Kshs. 165,940 or 352.5%. And although unskilled labor was to have been provided by the local people on a self-help basis, the actual amount paid to unskilled workers was about Kshs. 186,500 and accounted for nearly 18% of the total cost of each housing unit.

Cost of Building Materials

The 16.6% increase in the cost of building materials above what had initially been planned can be attributed to two major factors: (1) the delays in project implementation and the resulting increase in the cost of building materials over time and (2) the substantial increase in the amount of cement used during the project. With respect to the first factor, on a nationwide basis the cost of building materials for residential house construction rose by about 22% from July of 1982 when the initial pricing was done to October of 1985 when the project was officially handed over to the housing co-operatives.[3] The rise in the price of cement from July of 1982 to March of 1985 is a good example of how the cost of building materials increased during the project period. In July of 1982 the price of cement was Kshs.65 for a 50 kg. bag. By March of 1985 the price had risen to Kshs. 81/35, an increase of 25%.

Second, much more cement was used during the IRT project than had originally been anticipated. The original Project Activity Paper estimated that 1000 bags of cement weighing 50 kg. each would be required and that each bag would be purchased for Kshs. 65, thus making a total expenditure on cement of Kshs.65,000. In reality, the price of cement had risen to Kshs.68/90 by the time the first bag of cement was purchased, and by the end of the project nearly Kshs.154,841 had been spent on 2110 bags of cement. Table 4.3 presents a summary of the price of cement at various times during the project, the number of bags purchased at each price, and the total amount spent on cement during the course of the project.

Time Period	Unit Price 50 kg. bag (Kshs.)	Number of 50 kg. bags Purchased	Total Cost of 50 kg. bags Purchased (Kshs.)
July 1982 to January 1983	65	0	0
February 1983 to February 1985	68/90	1350	93,015
March 1985 to October 1985	81/35	760	61,826
July 1982 to October 1985	73/38 (avg.)	2110	154,841

TABLE 4.3: RISE IN CEMENT PRICES DURING THE PROJECT PERIOD.

Source: IRT Project Files.

Although the initial estimate of 1000 bags of cement may have been a bit low, the need to use more than double that amount was also a result of wastage, variations in the original design of the houses, and the failure of the hydraulic component of the "Brepak" machine to function properly at three project sites. First, in terms of wastage more than 6000 soil-cement blocks at Makunda, Ruambwa, and Nyamuga primary schools were damaged by rain and could not be used. Besides these, additional soil-cement blocks at Nyamuga and Lambwe schools were slightly damaged by rain. Although they were still usable, their durability and strength had been lessened by the effects of the rain. Consequently, the houses at these schools were rendered externally with a sand-cement slurry to provide additional protection from the rain. Of course, this required the use of a large amount of cement that had not originally been planned for.

Additional cement losses resulted from the following. Several bags of cement were damaged by rain. Others were borrowed by members of the local community and were never replaced. During the early stages of the project before the artisans had gained much experience, cement losses due to variations in mix proportions and use of wrong measurements during the setting out of the houses were substantial. However, it is important to note that the wastage of cement could have been decreased considerably if constant on site supervision had been provided at each of the five project sites.

Second, in terms of variations in the original house design, there was one in particular that consumed a significant amount of cement. At Lambwe, Nyamuga, and Budalangi primary schools a large amount of cement was used in forming a number of steps leading up to the doors of the houses (Plate 4.6).

Third, when the hydraulic component of the "Brepak" machine failed to operate properly during the block production phase at Budalangi, Makunda, and Lambwe primary schools, the percentage of cement added to the soil-cement mixture had to be doubled from 5% to 10% to ensure that the blocks produced had sufficient strength in compression.

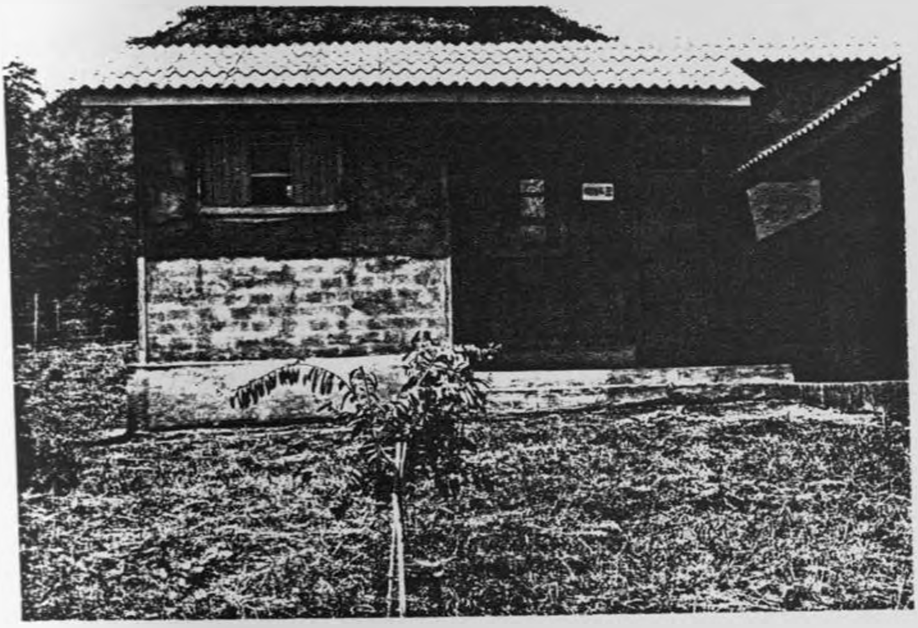


PLATE 4.6: IMPROVED TEACHERS' HOUSE AT LAMBWE PRIMARY SCHOOL - NOTE THE STEPS

Cost of Labor

The increase in labor costs over what had initially been planned can be attributed to three major factors: (1) the delays in project implementation and the resulting increase in the cost of labor over time, (2) the need to pay unskilled workers, and (3) low level of productivity of both skilled and unskilled workers. With respect to the first factor, on a nationwide basis the cost of labor for residential house construction rose by approximately 66% during the project period.[4] Consequently, one would have expected that the initial cost estimate of Kshs.47,080 for skilled labor would have risen to at least Kshs.78,152 by the end of the project. However, the actual expenditure on skilled labor was about Kshs.213,000 which is nearly three times higher than one would have expected.

Second, since the local community was reluctant to perform unskilled tasks on a self-help basis, the decision was made to pay unskilled workers a small honorarium for the work they did. By the end of the project the total amount paid to unskilled workers was Kshs.186,500, a figure that was almost equal to the figure of Kshs.213,000 paid to skilled workers.

Third, since the project supervisor was not able to provide adequate supervision at all five sites on a daily basis and because there was little incentive for either the skilled or unskilled laborers to work hard, worker productivity was very low. In fact, many of those who were employed during the IRT project had previously been unemployed and since the workers were paid a daily amount regardless of the amount of work they did, the tendency was to do a small amount of work each day and thus prolong the project and hence their period of employment. Without daily on site supervision by the project supervisor it was difficult to ensure that the people were working when they were supposed to be.

Instead of accounting for 8% of the total cost of each house as had originally been planned, the cost of labor actually ended up accounting for nearly 39% of the total cost of each housing unit. Normally, even in the contractor-built method of house construction with its overheads and profits, the labor component accounts for only 27.5% of the cost of the house.[5] Consequently, one can say that the expected savings normally associated with the use of local labor never materialized in this particular project.

Because of the high cost of labor in this particular project the total cost of each housing unit was nearly Kshs.103,000 which was 2.1 times higher than had been expected. However, if unskilled labor had been provided freely and if the cost of skilled labor had been closer to the original estimate, the cost of each unit would have been closer to Kshs.62,819 which was the cost per unit for materials only. But even Kshs.62,819 was still 40% higher than the original estimate of Kshs.44,893 per unit for materials only.

In the IRT project the total cost of materials and labor for each housing unit was approximately Kshs.103,000; which was a 110% increase over the initial estimate of Kshs.48,817 per unit. Of this 110% increase, 29% can be attributed to the increased expenditure on building materials and 81% can be attributed to the increased expenditure on labor. In this particular case study the cost of local labor increased the total cost of each housing unit substantially.

Cost Comparison

Having concluded that the cost of building materials increased the total cost of each housing unit by 29% , one can now compare this increased cost with the cost of the IRT housing unit if it had been constructed using conventional building materials. Table 4.4 presents a comparison between the cost of the building materials used in a conventional housing unit and the cost of materials used in the IRT housing unit. The comparison is for building materials only; it does not include the cost of labor. The prices quoted are for June of 1984 in Nairobi.

House Component	Conventional Housing Unit	Cost (June 1984)	IRT Housing Unit	Cost (June 1984)	Estimated Cost Reduction (June 1984)
1. Foundation	Strip type with 75 mm mass concrete foundation base of 1:3:6 mix with 3 courses of concrete block foundation footing and 200 mm of compacted hardcore	Kshs.1000 per m^3	Same	Same	No difference
2. Ground Floor Slab	100 mm thick mass concrete of 1:3:6 mix on top of 200 mm compacted hardcore	Kshs.250 per m^2	Same	Same	No difference
3. Walls	150 mm solid concrete blocks or stone blocks	Kshs.150 per m^2	Stabilized "Brepak" soil blocks	Kshs.80 per m^2	Kshs.70 per m^2
4. Roof	G.C.I. sheets on either deep timber purlins or sheets on timber truss structure	Kshs.110 per m^2	On-site locally produced sisal-cement roofing sheets on deep timber purlins spanning across load bearing cross walls	Kshs.65 per m^2	Kshs.45 per m^2
5. Doors	Normally tongue-and-groove externally and flush doors internally	Kshs.300 per complete door	Tongue and groove doors and door frames locally made.	Kshs.260 per complete door	Only Kshs.40 per door due to cheap labor

6. *Windows*	Normally steel frames and glass panels	Kshs.700 per unit	Timber frames and tongue and groove shutters locally made	Kshs.350 per unit	Kshs.350 per unit
7. Floor Finish	Normally cement screed	Kshs.40 per m^2	Same	Same	No difference
8. Wall Finish	Normally sand-cement plaster on both sides or internally only and painted	Kshs.50 per m^2	Fair faced on both sides	Kshs. 0 per m^2	Kshs. 50 per m^2
9. Ironmongery	Normally mortise locks	Kshs.300 per door	Hasp and staple and bolt internally	Kshs.180 per door	Kshs. 120 per door
10. Water Supply	Normally piped water	Kshs.2000 for plumbing and installation	Rain water collection tank and storage	Kshs.500	Kshs. 1500 per house
11. Sanitation	Normally water borne with high level or squatting WCs	Kshs.3000 per unit installed	Ventilated improved pit latrines.	Kshs.1800 per unit	Kshs.1200 per house plus savings during use
Cost per m^2	-	Kshs.1600 and above	-	Kshs.960 and below	Kshs.640 and above

TABLE 4.4: COST COMPARISON BETWEEN A CONVENTIONAL HOUSING UNIT AND ONE OF THE IRT HOUSING UNITS.

Source: Kateregga, 1984, pp.11-15.

The figures presented in Table 4.4 assume a reasonable amount of wastage of building materials. According to the table the cost of conventional house construction per m^2 was Kshs.1600 in June of 1984 whereas the cost of constructing an IRT housing unit was approximately Kshs.960 per m^2, thus representing a reduction in the cost of conventional house construction of 40%. This is the percentage reduction that one would have expected in the IRT project based on 1984 prices.

However, because of the unusually large amount of material wastage in the IRT project, the percentage cost reduction was not quite that much. Given that the actual cost for building materials for one housing unit in the IRT project was Kshs. 62,819 and that the total floor area for one unit including the main house and two kitchens is 53 m^2, the cost per m^2 for the building materials was Kshs.1185 which is slightly higher than the expected cost per m^2 of Kshs.960. Even with the large amount of material wastage in the IRT project, the cost of an IRT housing unit per m^2 was still 26% lower per m^2 than the same housing unit constructed with conventional building materials.

Summary

From the IRT project one can conclude that the use of improved indigenous building materials such as stabilized soil-cement blocks and sisal-cement roofing sheets can significantly reduce house construction costs, especially when material wastage is controlled through constant on site supervision. However, this particular project was not a good demonstration of how local community participation in the construction process can lower housing costs.

In this project there was minimal community participation; both skilled and unskilled tasks were performed on a paid basis. Because of the need to pay unskilled workers and the low productivity of both skilled and unskilled workers, the expenditure on labor was nearly 8.5 times higher than had been originally expected. As a result, the major increase in the total cost of each IRT housing unit can be primarily attributed to the increased expenditure on labor, not the increased expenditure on building materials.

Quality

Quality of house construction is another key indicator of how efficiently project implementation was carried out. Given the original project objectives of cost-reduction and self-help in materials production and the construction process, it was important to ensure that adequate quality standards were attained in the construction of the demonstration houses. Can costs be lowered while at the same time maintaining a sufficiently high standard of construction? Sometimes quality can be compromised during the construction phase in order to lower initial costs, but in such a situation the initial savings may be lost due to higher maintenance costs.

The overall quality of the houses built in this demonstration project was dependent on two key factors: the technical properties of the building materials themselves and the skill with which the materials were assembled. Consequently, this section of the evaluation will examine the degree to which the technology and community participation aspects of the project were able to contribute to a high quality of housing.

Technology

In terms of the technology, the quality of the improved indigenous materials can be compared to the technical properties of conventional building materials and the requirements of the Kenya Building Code. This constitutes a technical evaluation of the quality of the materials. However, their quality can also be measured in terms of their acceptability to the inhabitants of the houses. It is possible for a building material to compare favorably in all technical respects with conventional building materials and yet be rejected by the users for other reasons. For example, in Kenya the use of building stone and concrete blocks for wall construction signifies a certain status of the home-owner; and any other type of wall material, regardless of its properties, is generally seen as being inferior.

Technical Evaluation

Soil-cement Blocks

In terms of the technical properties of soil-cement blocks, the principal ones for which control measures are generally sought are compressive strength, permeability, density, thermal conductivity, and durability. Table 4.5 gives specific values of these properties for four different wall materials. From

Property	Field clay bricks	Dense concrete bricks	Lightweight concrete blocks	Stabilized soil-cement blocks
Wet compressive strength (MN/m^2)	10 to 60	7 to 50	2 to 20	1 to 40
Reversible moisture movement (% linear)	0 to 0.02	0.02 to 0.05	0.04 to 0.08	0.02 to 0.2
Density (g/cm^3)	1.4 to 2.4	1.7 to 2.2	0.6 to 1.6	1.5 to 1.9
Thermal conductivity (W/m^oC)	0.7 to 1.3	1.0 to 1.7	0.15 to 0.7	0.5 to 0.7
Durability under severe natural exposure	Excellent to very poor	Good to poor	Good to poor	Good to very poor

TABLE 4.5: RANGE OF PROPERTIES OF SOIL-CEMENT BLOCKS AND SELECTED CONVENTIONAL BUILDING MATERIALS.

Source: United Nations Industrial Development Organization (UNIDO), 1984, p.5.

the table, one can compare the properties of stabilized soil-cement blocks with those of three conventional wall materials.

Compressive Strength

The compressive strength of stabilized soil-cement blocks varies enormously depending on the soil type, the percentage of cement in the soil-cement mixture, and the amount of pressure applied to the mixture by the soil block press. Fired clay bricks exhibit tremendous strength even when saturated with water. Concrete bricks and lightweight concrete blocks have sufficient strength, but both require a significant amount of cement which is very expensive.[6]

Many types of soil have sufficient compressive strength when dry, but this strength is considerably reduced once they become saturated with water. However, stabilizers such as cement or lime can be used with certain soils to significantly improve wet strength. Although the wet compressive strength of soil-cement blocks is not quite as good as the three conventional materials, it still compares favorably.

Moisture Movement/Permeability

Most porous building materials expand when wetted and contract again as they dry. Excessive movement can cause cracking or other failures in buildings. From Table 4.5 one can see that this reversible expansion is very small in fired clay bricks. Concrete bricks are unlikely to have more than a fairly small amount of moisture movement, but lightweight concrete blocks exhibit greater movement which sometimes leads to shrinkage cracking in buildings as they dry out initially. Soil, especially plastic clay, may depict a rather large moisture movement. This is a major cause of failure in earth construction. However, the problem is reduced if stabilizers are added to the soil. Again, soil-cement blocks, when properly stabilized, compare favorably with the three conventional alternatives.[7]

Density and Thermal Conductivity

Fired clay bricks, concrete bricks, and stabilized soil-cement blocks are among the most dense of building materials and as such have good insulative characteristics and good thermal capacity. These characteristics are especially desirable in the tropics where daily extremes of temperature will be moderated inside buildings made of these materials. Lightweight concrete blocks have good thermal insulating properties but lack thermal capacity because of their comparatively low density.[8]

Durability

Evidence for the excellent durability of brickwork and earthwork can be seen in many countries of the world. Soil-cement blocks, if properly stabilized, will have good durability. However, in places where the rains are heavy lightweight concrete blocks and even soil-cement blocks may require rendering to improve resistance to water.[9]

Comparison to Kenya Building Code

Thus, one can say that the technical properties of soil-cement blocks compare quite favorably with conventional building materials. But do soil-cement blocks satisfy the Kenya Building Code requirements for wall construction? This question can be answered specifically by examining the properties of the soil-cement blocks which were actually used to build the houses at Nyamuga and Makunda primary schools. Although the Kenya Building Code does not apply to the houses constructed in this project since they are located in the rural areas, it is still worthwhile to assess the quality of the soil-cement blocks in terms of the code requirements for house construction in urban areas.

The results presented in Table 4.6 were obtained by HRDU through the testing of sample blocks from the two sites prior to the start of house construction. In the test two identical blocks were selected. One was immersed in water for 24 hours and was then subjected to a compressive load until it crumbled. The value recorded at the point of failure is the wet compressive strength. For this block, the water absorption ratio (i.e. percentage change in weight from the dry state to the wet state) was also recorded. In its dry state the second block was also subjected to a compressive load until it crumbled. In this case, the value recorded at the point of failure is the dry compressive strength. The percentage drop in strength from the dry state to the wet state is also indicated.

This test was carried out for two sets of blocks at each of the two sites. The test values for the dry compressive strength, wet compressive strength, and % water absorption of these blocks can be compared with the building code requirements and accepted standards for the same properties.

Site	Mixture	Soil Block Press	Block No.	Dry Weight (kg)	24 hr. Immer-sion	Wet Weight (kg)	Water Absorp-tion (%)	Dry Crush-ing Load (KN)	Wet Crush-ing Load (KN)	Dry Strength (MN/m^2)	Wet Strength (MN/m^2)	Drop in Strength (%)
Makunda	Sandy clay loam soil + 10% cement	Brepak (hydraulic component not functioning)	A1	8.30	Yes	9.15	10.24	-	80	-	1.93	43.6
			A2	8.35	No	-	-	142	-	3.42	-	
			B1	8.35	Yes	9.10	8.98	-	90	-	2.17	40.9
			B2	8.35	No	-	-	152	-	3.67	-	
Nyamuga	Sandy loam soil + 10% cement	Brepak (hydraulic component not functioning)	C1	9.36	Yes	9.55	2.03	-	350	-	9.44	34.2
			C2	9.35	No	-	-	532	-	12.83	-	
			D1	9.40	Yes	9.60	2.12	-	320	-	7.72	30.4
			D2	9.40	No	-	-	460	-	11.09	-	
Kenya Building Code Requirements and Accepted Standards							15.00 maximum Allowed			2.80 minimum Allowed		

TABLE 4.6: TECHNICAL PROPERTIES OF SOIL-CEMENT BLOCKS USED AT MAKUNDA AND NYAMUGA PRIMARY SCHOOLS

Source: Housing Research and Development Unit.

In terms of compressive strength the Kenya Building Code requires that the following standards be achieved. By-law 52 states:

> All walls built of stone, bricks, or blocks shall be hard, durable and suitable for the purpose for which they are, and shall be of resistance to crushing as laid down in rule 3 of the Third Schedule to these By-laws.[10]

Rule 3 of the Third Schedule states the following:

> Bricks or blocks used in any wall to which the Rules on this Schedule relate shall be composed of burnt clay, stone, concrete or sandlime and have a resistance to crushing of not less than 400 lb. per sq. in. (i.e. 2.80 MN/m^2) of gross horizontal area where the wall is a wall of a small house as defined in by-law 71 of these By-laws or of a building of the same description divided into flats.[11]

By-law 71 defines a small house in the following terms:

> "Small house" means a one or two-storeyed dwelling house of a capacity of less than 20,000 cu. ft., but does not include a flat.[12]

By this definition the houses in this project can be considered "small houses" and consequently, the code requires that any blocks used in wall construction in urban areas must have a resistance to crushing of not less than 2.80 MN/m^2.

The code requirements do not specify whether the figure of 2.80 MN/m^2 is to be applied to the value for dry compressive strength or wet compressive strength. However, research institutions like HRDU assume that the figure applies to the value for the dry compressive strength since it is very unlikely that any wall in normal use would ever be subjected to conditions similar to the test in which a soil-cement block is immersed in water for 24 hours. This is especially unlikely if the walls are protected from the rain by long roof eaves.

It is important to note at this point that in addition to requiring that wall materials meet certain performance standards (e.g. minimum compressive strength of at least 2.80 MN/m^2), the Kenya Building Code also specifies precisely what materials can be used for wall construction (i.e. bricks or blocks composed of burnt clay, stone, concrete or sandlime). Soil-cement blocks are not included in the list of suitable materials for wall construction.

From Table 4.6 one can see that the blocks at both Nyamuga and Makunda primary schools were made from a mixture of sandy soil and cement. After mixing these ingredients together the mixture was placed in a Brepak soil block press for compaction. However, in both cases the hydraulic component of the Brepak machine was not functioning, and consequently, the magnitude of compaction was similar to that of the

Cinva-Ram soil block press.

In terms of dry compressive strength, each of the four blocks tested surpasses the minimum requirement in the Kenya Building Code of 2.8 MN/m^2. In terms of the water absorption percentage all four blocks are well below the generally accepted maximum allowable value of 15%. Thus, one can conclude that the properties of soil-cement blocks (i.e. in terms of compressive strength and water absorption percentage) satisfy the Kenya Building Code performance standards for wall construction in urban areas.

Some opponents of the use of stabilized soil-cement blocks in wall construction argue that the long-term durability of the blocks is still questionable. However, there is satisfactory evidence in Kenya that the use of earth in house construction remains quite durable over time. For example, the durability of mud-and-wattle wall construction has been demonstrated in the Pumwani area of Nairobi where most of the structures have stood since 1923, when they were first erected, with little or no maintenance.

A second example is the old Kariobangi site-and-service housing scheme in Nairobi where allottees were allowed to build mud-and-wattle houses on their plots as temporary shelters. However, many of these temporary houses were never replaced and have been standing since 1964 when they were first built. Certainly the improvements in earth construction introduced through the concept of soil stabilization will lengthen the life of earth walls by many more years.

Sisal-cement Roofing Sheets

In terms of the technical properties of corrugated sisal-cement roofing sheets, the principal ones for which control measures are generally sought are bending strength and impact strength, durability, permeability, and thermal conductivity. The following discussion will compare the above properties of sisal-cement sheets with those of two commonly used conventional roofing materials, that is British Standard corrugated asbestos-cement sheets and 26 gauge corrugated galvanized iron sheets. Although the sisal-cement technology has been tried out in a number of developing countries, the technical findings presented below are based on the Kenyan experience with the technology.

Bending and Impact Strength

During their lifetime, roofing sheets may be subjected to many kinds of loads in addition to their own weight. There may be permanent loads, temporary loads due to high wind pressure or people, and impact loads during manufacture, transport, construction or afterwards. Generally, the sisal-cement sheets produced in Kenya are strong and can withstand wind loads up to 'light' hurricane loads (125 mph). The sheets have about 45% of the strength of the British Standard asbestos-cement sheets in bending, but the impact strength is 2.5 times higher.[13]

Despite the fact that sisal-cement sheets have only 45% of the bending strength of asbestos-cement sheets, sisal-cement sheets may be used with an adequate factor of safety, provided that the purlin spacing is reduced to 0.8 m. At this spacing the bending strength of sisal-cement sheets surpasses that of asbestos-cement sheets.[14]

Durability

The most serious problem concerning the long-term durability of sisal-cement sheets is that the sisal fibers may begin to decay in the alkaline environment of the cement matrix. It is suspected that fiber decay could reduce the sheets' bending strength, lessen their impact resistance, and increase their vulnerability to porosity and cracking. However, present evidence suggests that the cement protects the sisal fibers from decay, but this view will have to be substantiated by test results over time.[15]

Table 4.7 gives an indication of the relative lifetimes of different roofing materials.

Roofing Material	Lifetime (years)	Comments
Asbestos-cement	20-40	
Galvanized iron	5-20+	Depends on gauge. Roof on Blantyre Church, Malawi has lasted 60 years.
Sisal-cement	8-?	Oldest sheets are 8 years and still in good condition

TABLE 4.7: DURABILITY OF ROOFING MATERIALS.
Source: Sakula, 1982, p.129.

The lifetime of sisal-cement sheets is currently estimated at more than eight years. No deterioration due to aging has been observed so far with sheets made by the short-fiber process. From the table one can see that the proven durability of both asbestos-cement and galvanized iron sheets is considerably longer than that for sisal-cement sheets. However, durability tests on sisal-cement sheets are still inconclusive.

Permeability

Keeping out the rain is one of the most important functions of a roof. If properly made and installed, sisal-cement sheets are quite adequate for this purpose. However, problems have arisen where lack of care in production has led to cracks and/or porosity in the sheets. D.G. Swift and R.B.L. Smith state that properly manufactured sheets are completely impermeable to water under normal conditions.[16] In this respect, sisal-cement sheets perform just as well as both asbestos-cement and galvanized iron sheets.

But of course the waterproofness of the roof as a whole depends on factors other than the soundness of individual sheets. It is important that recommendations for minimum laps and pitches are followed, that side laps are correctly made, and that ridge joint details are waterproof. During April and May of 1986, i.e. during the "long rains", there was substantial leaking through the ridge joints on all of the IRT housing units (Figure 4.3).

From the figure one can see that the joint where the two roofing sheets meet was filled with cement mortar to keep out the rain. At each house the differential settlement of the structure since the roofing sheets were fixed into place caused the

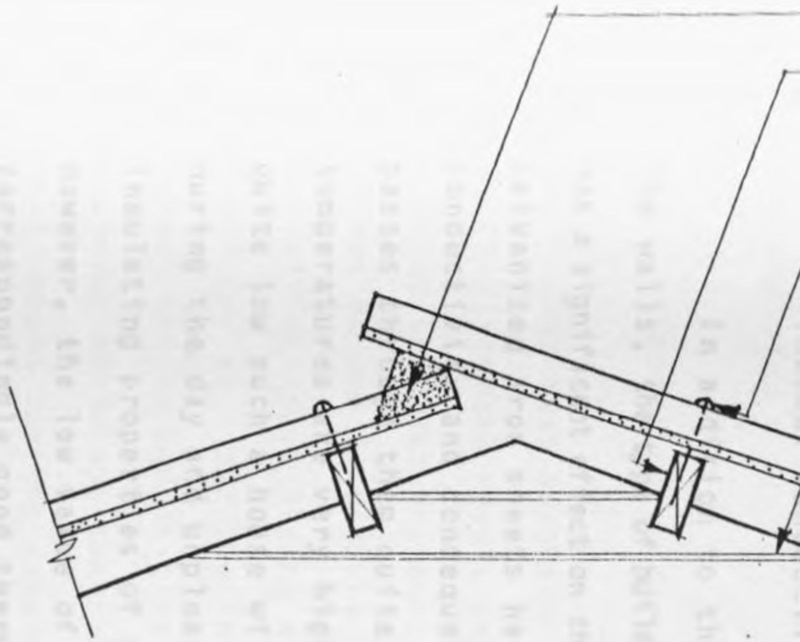
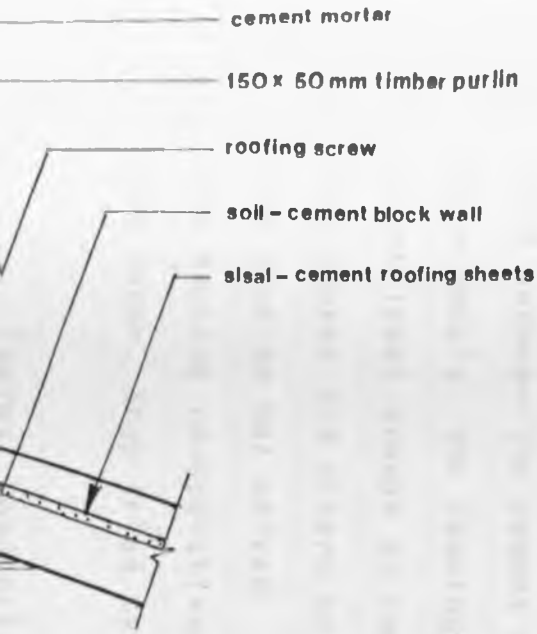


FIGURE 4.3: DETAIL OF RIDGE JOINT


cement mortar
150 x 50 mm timber purlin
roofing screw
soil – cement block wall
sisal – cement roofing sheets

bond between the cement mortar and roofing sheets to crack. As a result, the leaking in the IRT houses was significant enough to cause a few teachers to leave the houses and others to refuse to pay rent until the problem was solved. Initially, the officials of the housing co-operatives turned to HRDU for assistance, but later, they tried to solve the problem on their own.

Thermal Conductivity

In addition to the building materials used for the walls, the type of building material used on the roof also has a significant effect on the thermal environment within the house. Galvanized iron sheets have a very high rate of thermal conductivity and consequently, the heat from the sun passes through them quite easily. In Kenya where daily temperatures are very high and nightly temperatures are quite low such a house will become very warm inside during the day and unpleasantly cool at night since the insulating properties of galvanized iron are almost nil. However, the low value of thermal conductivity and correspondingly good thermal insulating properties of both asbestos-cement and sisal-cement sheets moderate the temperature inside buildings and thus contribute to a thermally comfortable interior environment.

Thus, one can say that the technical properties of sisal-cement sheets compare quite favorably with those of conventional roofing materials like asbestos-cement and galvanized iron sheets. The only major question concerning the use of sisal-cement roofing sheets is their long-term durability. Otherwise, if properly manufactured, stored, and installed; their short term performance has proven to be quite satisfactory.

Comparison to Kenya Building Code

The next question to consider is whether or not sisal-cement sheets satisfy the minimum Kenya Building Code requirements for roofing materials. By-laws 94 and 96 require that the roof of a building or dwelling house having a capacity of less than 36,000 cu. ft. shall afford adequate protection against the spread of fire into the building or to adjoining buildings and shall be weatherproof.[17] Sisal-cement roofing sheets satisfy both of these performance criteria.

However, as was the case with wall materials the building code also specifies precisely what kind of building materials can be used for roof construction. Although asbestos-cement and galvanized iron sheets are both considered suitable roofing materials, sisal-cement sheets are not mentioned in the code. Consequently, the building code by omission currently prohibits the use of sisal-cement roofing sheets in Kenya's urban areas even though they satisfy the code's performance standards.

Qualitative Evaluation

The overall quality of the house including that of the building materials can also be measured by the degree to which the tenants of the houses find them to be acceptable. By technical standards the quality of the houses has been found to be quite high. This section will reveal whether or not the residents of the houses agree with the findings from the technical evaluation.

The responses of the tenants to various characteristics of the IRT housing units are presented in Table 4.8. At the time the survey was conducted there were ten different tenants living in the seven occupied houses. Five of the tenants were interviewed. Of the five interviewed, two had previously lived in urban settings in houses built with conventional building materials. The other three had previously lived in rural settings in houses built with traditional building materials. The respondents were asked to indicate whether they thought each of the characteristics of the IRT housing units was "Good", "Average", or "Poor". The numbers presented in Table 4.8 are the numbers of individual responses to each characteristic. The numbers are not percentages.

	1			2			3		
Characteristics of the IRT Housing Units	Rural Respondents			Urban Respondents			Total Number of Respondents		
	Good	Average	Poor	Good	Average	Poor	Good	Average	Poor
1. Floor material (cement)	2	1	0	1	1	0	3	2	0
2. Wall material (soil-cement blocks)	3	0	0	1	1	0	4	1	0
3. Roof material (sisal-cement sheets)	2	0	1	1	0	1	3	0	2
4. Comfort of the Interior Environment in terms of the Temperature inside the House	2	1	0	2	0	0	4	1	0
5. Visual Appearance of the House	1	2	0	0	2	0	1	4	0
6. Durability of the Wall and Roof Materials	1	2	0	1	1	0	2	3	0
7. Resistance of the Roof to Water Penetration	1	2	0	0	0	2	1	2	2
8. Overall Quality of the House	3	0	0	1	1	0	4	1	0
Total Number of Responses	15	8	1	7	6	3	22	14	4

TABLE 4.8: TENANTS' RESPONSES TO QUALITY CHARACTERISTICS OF THE IRT HOUSING UNITS.

Source: Field Survey.

From column 3 one can see that the overall response to the quality of the houses was quite positive. There were 22 "Good" responses, 14 "Average" responses, and only 4 "Poor" responses. A comparison of the total number of responses from rural and urban respondents reveals that the urban respondents were more critical in their evaluation of the houses. Of course, this is only natural since they had previously been living in houses built with conventional building materials. Although they were more critical, they still rated most of the characteristics of the IRT housing units as "Good" or "Average". This seems to indicate that urban residents in other parts of Kenya might also be willing to live in houses built with improved indigenous building materials.

The majority of the respondents indicated that the floor material, wall material, roof material, comfort of the interior environment, and overall quality of the houses were "Good". However, the majority considered the visual appearance of the house and the durability of the wall and roof materials to be "Average." All of the "Poor" responses were with reference to the roofing materials and the fact that rain water was leaking through the ridge joint. It is interesting to note that despite the leaking, the rural respondents still considered the roof performance to be in the "Good" and "Average" categories whereas the urban respondents considered the performance to be "Poor".

From the qualitative evaluation of house quality based on the tenants' responses one can conclude that the tenants agree with the findings from the technical evaluation. The overall quality of the houses including that of the building materials was found to be quite high by professionals and tenants alike. The major problem with the houses was that the roofs were leaking at the ridge due to a faulty design detail.

Community Participation

In addition to the contribution made by the technical properties of the building materials themselves, the overall quality of the teachers' houses was also dependent on the skill with which the materials were assembled. In fact, it is possible for the individual building components (e.g. soil-cement blocks and sisal-cement roofing sheets) to be of very high quality and yet the overall quality of the building can be quite low when the individual components have been assembled in a shoddy manner.

Based on the preceding technical and qualitative evaluation, the overall quality of the houses was found to compare quite favorably with conventional housing. Consequently, this section identifies which factors associated with the community participation aspect of the project contributed to the high quality of the houses. Basically there were three groups of people who played critical roles in the construction of the teachers' houses: a project supervisor who was affiliated with the assisting agencies in Nairobi (i.e. USAID and HRDU), skilled workers from the study area, and unskilled workers from the study area. Their roles can be assessed in light of the two major tasks involved in the construction of the houses, that is, the production of the building materials and the assembly of the building materials.

Materials Production

The high quality of building materials produced on site by unskilled workers can be attributed to several factors. First, prior to the start of house construction, the foremen for each of the six sites in Bunyala and Mbita were taken to Kabiro village in Nairobi for a three-week training course in which they learned how to make soil-cement blocks and sisal-cement roofing sheets and how to assemble the materials produced. Consequently, before construction actually began the site foremen, who were all skilled masons from the study area, were already very familiar with the building materials they would be making and using on site.

Second, in addition to the fact that there was a skilled mason at each of the project sites who was already conversant with the techniques for materials production, the project supervisor from HRDU demonstrated to the unskilled workers at each site how to produce the required materials. In fact, the demonstration of techniques for materials production marked the beginning point for materials production at each site.

After the initial training session on site and a few days of close supervision by the project supervisor, the unskilled workers were capable of producing building materials of sufficiently high quality. If they had any questions, they could always ask the site foreman for assistance. And third, during his monthly visit to the site, the project supervisor checked to ensure that the quality of the materials being produced was acceptable. This project reinforced the findings from the Kabiro project that the production of materials on site is a relatively simple process and can be learned by a group of previously unskilled workers in two to three weeks.

Although the building materials produced at the project sites were of a high quality, the need for unskilled workers to exercise care in their production should not be underestimated. In fact, those making the materials must ensure that proper precautions are taken with respect to the following: (1) that the proper proportion of ingredients is added to the mixture, (2) that both soil-cement blocks and sisal-cement sheets are allowed to cure properly, and (3) that the materials produced, especially the soil-cement blocks, are properly protected from the rain before use. Actually, during the course of the project more than 6000 soil-cement blocks became unusable when they were carelessly exposed to the rain.

Assembly of Materials

Although the project supervisor was only able to be on site at each of the five project sites for two days each month, the overall quality of the houses resulting from the skill with which the building materials were assembled was also quite high and can be attributed to several factors.

First and most important, skilled artisans were involved in the construction of the houses. Skilled masons were responsible for tasks involving the use of cement such as the construction of foundations, floor slabs, and walls. Skilled carpenters built the roof structure, the doors and frames, and the window frames and shutters; and they attached the sisal-cement roofing sheets to the roof structure. Although they were assisted by unskilled workers, the skilled artisans were still primarily responsible for assembling the building materials. In fact, one of the project supervisors from HRDU emphasized how important it was to have skilled artisans involved in the construction process.

Second, since the techniques of laying soil-cement blocks and fixing sisal-cement roofing sheets are so similar to conventional construction techniques, it was relatively easy for the skilled artisans to adjust to the minor changes in assembly techniques associated with the use of improved indigenous building materials. Although worker productivity was generally low, at least the work that was done was of a high quality. In fact, since the project supervisor was only at each construction site for two days each month, the high overall quality of the houses resulting from the careful assembly of the building materials was primarily due to the contribution made by the skilled artisans.

Third, the project supervisor tried to schedule his site visits so that he could be on site whenever critical tasks like pouring the floor slab were carried out. He also tried to be on site when the first two courses of soil-cement blocks were being laid since the first two courses normally established the standard of quality that was expected for the remainder of the wall. Consequently, by being present when important tasks were being performed, the project supervisor was able to indicate to the skilled artisans what degree of quality was expected. Besides the project supervisor's monthly site visits, the project representative from USAID and the director of HRDU also monitored the progress of the project on a periodic basis and thus ensured that proper quality control was maintained.

Fourth, the three-week training session at Kabiro village also helped the site foremen to adjust to the minor changes in construction techniques associated with the use of soil-cement blocks and sisal-cement roofing sheets, and thus contributed to the overall quality of the housing units.

Fifth, in terms of maintaining quality during the construction process, the project supervisor only needed to be on site two days each month since there were skilled artisans on site who could ensure that the desired standard of quality was maintained. For maintaining quality, periodic supervision was sufficient; but for maintaining worker productivity, constant on site supervision was needed. However, one of the project supervisors from HRDU did not think that it was necessary to have someone of his caliber providing daily on site supervision. In fact, by the end of the project he thought that two of the skilled artisans who served as site foremen, one from Bunyala and one from Mbita, had acquired the skills necessary to provide on site supervison in future projects using the same building materials and construction techniques.

Summary

In terms of the technology, one can say that the technical and qualitative evaluations of the use of soil-cement blocks and sisal-cement sheets in house construction reveal that both professionals and tenants alike consider these improved indigenous building materials to compare quite favorably with the properties of conventional building materials and in some respects (e.g. noise absorption and comfort of interior environment) perform even better. It can also be concluded that soil-cement blocks and sisal-cement sheets satisfy the performance standards of the Kenya

Building Code. However, since the code is not based on performance criteria alone but also specifies which building materials are acceptable for wall and roof construction, the omission of soil-cement blocks and sisal-cement sheets from the list of acceptable materials renders them unacceptable for use in Kenya's urban areas.

In terms of the community participation aspect of the IRT project, the involvement of skilled and unskilled workers from the study area in the house construction process did not have a negative effect on the overall quality of the houses. But rather, because of proper on site training and supervision, unskilled workers were able to produce soil-cement blocks and sisal-cement sheets of high quality. And skilled artisans, after adjusting to the minor changes in construction techniques associated with the use of these materials, were able to use these materials to construct houses having an equally high quality.

Replicability

From the policy maker's viewpoint, replicability is another measure of project efficiency. The fact that ten houses have been built in Hakati and Mbita constituencies is certainly no major accomplishment in itself, but if the project was designed and implemented in such a way that it can be replicated on a larger scale, then it has tremendous potential for making a significant contribution to increasing the housing stock in the study area in particular and Kenya in general. This section will examine the degree to which the technology and community participation aspects of the project have potential for replication on a larger scale. This potential will be measured on the basis of five criteria for replicating the project: local acceptability, appropriateness, reasonableness of costs, demand for the technologies, and supply of the technologies.

Local Acceptability

Housing projects and technologies will not be replicable unless they are broadly acceptable. Acceptability is a function of both government attitudes and popular response. At the beginning of the IRT project, people in Bunyala and Mbita resisted the idea of using earth as a building material for permanent house construction because they saw it as being an inferior material. However, as the houses were constructed and as people observed the high quality of the building materials, the use of soil-cement blocks and sisal-cement roofing sheets rapidly gained acceptance by members of the local community. Although the design of the IRT housing units varies significantly from the traditional Luhya or Luo house, most of the people in the study area associate the IRT houses with progress. They are seen by many people as the type of house one should aspire to attain. However, there are a few others who are a bit skeptical about the durability of the materials and thus choose to monitor the performance of the building materials for a few more years before they invest in such a house.

In Bunyala and Mbita the technology received strong political support from both MPs, primarily because they had seen the health clinic at Kabiro and were impressed by its high quality and low cost. As long as the technology is used in the construction of houses in the rural areas of Bunyala and Mbita, it appears as though its use will receive support from both the local people and government agencies. However, based on the negative reaction toward the technology demonstrated by government agencies and local authorities at Mado Gashi, Nyahururu, and Nairobi; it appears as though its use in the urban areas of Bunyala and Mbita may similarly meet some resistance from the local authorities. But if the suggested revisions to the Building Code allowing the use of local building materials in Kenya's urban areas are approved, government agencies and local authorities will have no basis for resistance.

Appropriateness

Technology and community participation are considered appropriate when they address themselves to the needs, resources, and abilities of the local people. In many respects the technology used in the IRT project was quite appropriate for the local situation in Bunyala and Mbita. The high insulative values inherent in the properties of soil-cement blocks and sisal-cement sheets are an appropriate response to the high daily fluctuations in temperature common to the study area. Thermally the performance of these building materials approximates that of traditional building materials and thus provides a cool interior environment when it is hot outside and vice versa. However, unlike the deep overhangs characteristic of the traditional Luhya or Luo house, the depth of roof overhangs on the IRT housing units may not adequately protect the walls from the heavy rains in the area, especially at the end walls (Plate 4.7).

The technology utilized in the IRT project was also appropriate in the sense that it used building materials which were primarily available in the study area. At all five sites the soil was extracted directly from the site and block production was performed on site, hence reducing some of the transport costs associated with the use of conventional building materials. The soil was free; it was available on site; and it was a material that the people were already familiar with.

Although sisal was not available directly on site at some locations, it was available locally and could be purchased for Kshs.3 per kilogram. Sisal-cement sheets were produced on the project site at Nyamuga, Lambwe and Ruambwa primary schools, thus reducing transport costs. Although sisal-cement sheets had to be transported from Ruambwa to Makunda and Budalangi, the transport of the sheets was carried out by local workers using local methods of transport.

Although the use of improved indigenous building materials in house construction requires substantially less cement than the use of conventional building materials, the production of soil-cement blocks

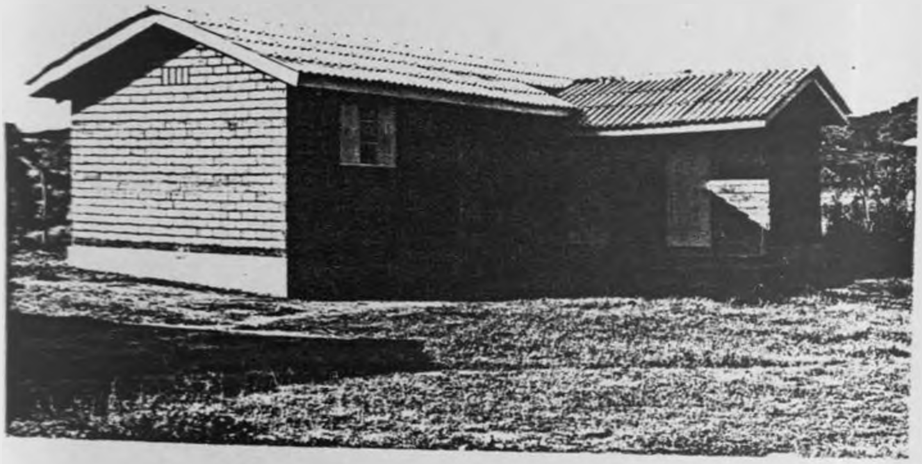


PLATE 4.7: IMPROVED TEACHERS' HOUSE AT BUDALANGI PRIMARY SCHOOL - NOTE THE SHALLOW DEPTH OF THE ROOF OVERHANG AT THE END WALLS

and sisal-cement sheets still requires the use of some cement, a material which is not always readily available. Consequently, as long as cement remains one of the required ingredients in the production of these materials, one can expect project delays resulting from its uncertain availability.

For this reason, in the future construction of teachers' houses this technology may not always be the most appropriate choice. It is always best to use what is locally available in terms of materials. Although soil-cement blocks were used in the IRT project, murram stone was locally available at Ruambwa and Budalangi and rough stone was available directly on site at Lambwe. In both cases the use of these materials may have been a less expensive option. However, these materials could not be supplied on demand, but required that an order be placed ahead of time. Consequently, the original plan to use soil-cement blocks was followed.

If this technology continues to be used in the construction of more teachers' houses in the study area, the "Brepak" block press is not the most appropriate machine for producing the soil-cement blocks. Its cost of Kshs.22,000 is nearly five times higher than other soil block presses manufactured in Kenya. Currently, the "Brepak" machine is manufactured only in Britain and consequently, some replacement parts can be obtained only from Britain. Although the hydraulic component of the "Brepak" machine enables it to produce blocks with a higher compressive strength, it was discovered during the IRT project that the hydraulic component broke down frequently. In fact, at three of the project sites the hydraulic component could not be used in the block production process because it was not working. Without the hydraulic component the "Brepak" exerts the same compaction force as the Cinva-Ram block press. However, the Cinva-Ram is manufactured in Kenya and costs only Kshs.4000.

In terms of the community participation aspect of the IRT project, the idea of using a combination of skilled and unskilled labor in which unskilled tasks are performed by members of the local community on a self-help basis is an appropriate one. In fact, this approach, if successful, has several advantages. It provides an excellent environment in which unskilled workers can learn basic masonry and carpentry skills from skilled workers in addition to learning how to produce the building materials. Because of the involvement of skilled workers, the quality of the houses remains high and yet the involvement of unskilled workers has the potential to keep labor costs quite low.

But in the IRT project this approach did not keep labor costs to a minimum. Because of inadequate on site supervision and the fact that payment of wages was based on a daily rate and not on performance, worker productivity was low and the cost of labor soared above the original estimate. The degree to which this approach will be replicable in future projects will depend on the make-up of the local community and the manner in which the project is introduced to them.

In the future construction of teachers' houses in Bunyala and Mbita, the housing co-operatives must be prepared to pay unskilled workers when the local community is reluctant to contribute unskilled labor freely. However, if payment is not based on a daily rate but on performance, the cost of the labor component should be kept to a minimum. And the total cost for both materials and labor should be less than the amount of Kshs.1185 per m^2 achieved in the IRT project.

Reasonableness of Costs

Costs to potential users of the technology in Bunyala and Mbita consisting of cash down payment, self-help contributions, monthly loan repayments and maintenance should be reasonable and within their means.[18] According to the original IRT project objectives, the purpose of transferring appropriate technologies to the people in the study area was to enable private individuals, the housing co-operatives, and other institutions to further replicate the technologies in the construction of houses, classrooms, health clinics, community halls, and other one-storey structures.

Given that the average rural family in Bunyala or Mbita earns less than Kshs.2600 per year it is not reasonable to expect such a family to be able to afford a house that costs approximately Kshs.62,819 for materials only. Even this amount is more than 24 times his yearly income, and normally financial institutions in Kenya are only willing to provide loans of up to 2½ times a person's yearly income.

However, this technology does provide an appropriate alternative for households which cannot afford conventional housing but still desire a house of high quality. For example, the proposed NHC housing project in Nyahururu plans to reach households earning between Kshs.600 and Kshs.800 per month. Even in Bunyala, there is already one private individual who has completed a house for himself using soil-cement blocks.

The cost of this technology also appears to be quite reasonable for the housing co-operatives in

Bunyala and Mbita. Since the housing co-operatives are currently receiving Kshs.500 per month in rent for each teacher's house, the co-operatives can obtain loans from financial institutions for the purpose of building more teachers' houses. They can use the accumulated rental income as a down payment while the existing teachers' houses serve as collateral.

According to the figures in this study, the cost of one IRT housing unit is Kshs.62,819 for materials only. Given the poor site supervision and low productivity of the workers one can assume that the cost of labor will not be as high in the construction of future houses. Assume that the cost of skilled labor is 15% of the cost of building materials and that unskilled labor is provided by the local people on a self-help basis.[19] Given these assumptions, the total cost of one housing unit is: 62,819 + (.15) 62,819 = Kshs.72,241.

Now assume that the financial institution requires a down payment of 10% of the total cost of the house. The amount of the down payment will be Kshs.7224. If the co-operative is collecting Kshs.500 per month for a given house, in about 14 months they will have collected enough rent to make a down payment on a new house. After the down payment is made, the

Kshs.500 collected each month in rent will be used to pay off the loan.

Now assume that this new house is completed and occupied in 6 months. After 14 more months the co-operative will have collected enough rent to make a down payment on another new house and so the process continues. At this rate a new house will be completed and occupied every 20 months. However, since the Bunyala housing co-operative already has 6 houses, they will be able to construct 6 new houses every 20 months. If everything were to remain constant until the year 2000, the co-operative would be able to construct 54 additional houses by that time. But if the co-operative were to continue obtaining loans on the basis of its fixed assets up to the year 2000, the rate of construction could be much faster.

Consequently, if the housing co-operatives manage themselves properly, they should be financially capable of building at least 54 additional teachers' houses by the year 2000 and thus fulfill the original objectives of the IRT project. One would also expect that other institutions in the study area will use these same technologies to build classrooms, health clinics, and other community facilities in the same way that organizations in Korogocho, Kabiro, and Mado

Gashi used the technologies to build primary schools and a health clinic at a fraction of the cost of similar facilities built according to conventional specifications.

Demand for the Technology

The potential for replicability can also be measured by the existing construction activities using the technology and the expected demand for the technology. If there is no demand for the technology, then of course it will not be replicated. In terms of existing construction activities there have been no additional developments in Mbita division since the co-operative assumed control of the project. In Bunyala though, as mentioned earlier, two different projects have already been initiated by private individuals in the area. A private house has already been completed, and a 40-unit housing project near Hakati town is currently under construction.

The expected demand for the technology can be described in terms of the short-term demand for the technology and the long-term plans of the housing co-operatives. In the short-term fifteen private individuals, ten in Bunyala and five in Mbita, have indicated a strong interest in using soil-cement blocks and sisal-cement sheets to build new houses for themselves. In fact, two teachers, a fisherman, and shopkeeper in Bunyala have already had the plans prepared.

Second, the School Parents Association at Makunda secondary school has expressed a desire to use the same technology in the construction of several classrooms at the school. It is expected that the project will be put up for tender.

Third, at Port Victoria the construction of the Bunyala Youth Polytechnic has already begun. Parents and children participated in the digging of the foundation. The polytechnic will consist of two classrooms and a store having a total floor area of 75 m^2. The coordinators of the project intend to use soil-cement blocks and sisal-cement sheets to construct the superstructure of the building. It is hoped that when people around Port Victoria see the technology firsthand that they too will decide to join the Bunyala housing co-operative. The project has already received a grant of Kshs.10,000 from the Kenyan Government.

Fourth, an external donor has volunteered to provide the finance for the construction of a secondary school for handicapped children near Lambwe primary school in Mbita division. When a representative of the donor agency visited the site and saw the high quality of the two teachers' houses at the primary school, he indicated that he would like to see the new secondary school constructed with the same building materials. The project has been submitted to the District Development Committee for approval.

The housing co-operative in Bunyala has the following long-term plans for the further replication of the technology. First, they want to build houses at other schools in the location. The goal is to build at least two houses at each of the thirty primary schools in Bunyala. Then they plan to start building more houses at the existing sites. Second, the co-operative plans to set up a small-scale industry for producing the soil-cement blocks and sisal-cement roofing sheets needed by the co-operative, but they also expect to sell the materials to private individuals too. And third, the co-operative wants to purchase some land on which they can build some small hotels and thus raise more money for constructing housing for teachers. The co-operative officials also mentioned that a group of private individuals in the area were interested in joining together to invest in rental housing. They too are interested in using the technology.

The Jonyoul Housing Co-operative Society in Mbita division has the following long-term plans for the further replication of the technology in their division. First, they would like to build two houses at one primary school in each of the five locations that did not directly benefit from the IRT project. In the long run it is hoped that each primary school in the division will benefit from the technology. Then they plan to start building more houses at the existing sites.

Second, they hope to use the same technology to build future classrooms when they are needed. However, the School Parents Association at each primary school is ultimately responsible for deciding whether or not to use the technology for this purpose. Third, the housing co-operative wants to set up a small industry for producing the sisal-cement roofing sheets, both for the use of the co-operative and for sale to private individuals.

Both the existing activities in the study area and the future plans of the housing co-operatives indicate that there is currently a demand in Bunyala and Mbita for the technology. Thus, one more requirement for replicability has been satisfied.

Supply of the Technology

Replicability of the technology is also dependent on its supply. Although the demand for the technology may already exist in both Bunyala and Mbita, if there is no one in the study area who can supply the technology and thus meet the demand, the technology will not be replicated. In Bunyala and Mbita the supply is directly dependent on the availability of technical skills and the capability of the housing co-operatives to replicate the technology.

Technical Skills

As discussed previously the technical skills required for the production and use of improved indigenous building materials have been successfully transferred from HRDU to the local people in Bunyala and Mbita. In fact, approximately 40 people in each constituency were strongly exposed to the technology, and one of the project supervisors from HRDU indicated that two of the skilled artisans who served as site foremen during the IRT project, one from Bunyala and one from Mbita, had acquired the skills necessary to provide on site supervision in future projects using the same building materials and construction techniques.

The ability of the site foreman from Ruambwa to provide satisfactory on site supervision has already been demonstrated by the successful completion of a house in Bunyala for a private individual. During the project he provided continuous on site supervision, and the house, which has an area of 200 m^2, was completed in a period of nine months.

It appears as though the required technical skills are presently available in each of the constituencies. Thus, the housing co-operatives have access to the skills necessary to enable them to continue with the construction of more teachers' houses in the future.

Capability of the Housing Co-operatives

Since the technical skills are present in the constituencies, one can now assess to what degree the housing co-operatives are capable of replicating the technologies. At this point it is important to note that the IRT project was heavily subsidized by USAID and HRDU. Although the contribution of the local community in terms of land, self-help labor, and local project management accounted for 26% of the total contribution; the major financial contribution accounting for 74% of the total was provided by USAID.

The contribution of HRDU was also substantial. In fact, HRDU was primarily responsible for the design and planning of the project, the training of the local people, the technical supervision of the project, the daily management of the project, and even the accounting of project funds. In the future replication of the technologies,the housing co-operatives will be expected to perform these tasks.

In effect HRDU performed many tasks that the housing co-operatives will be performing in the future. If the co-operatives had been more fully operational at the local level, the co-operative officials could have learned quite a bit about managing project implementation by observing and talking with the HRDU project supervisors. Such interaction could have been extremely profitable, especially since it was not a part of the original project plan to provide co-operative officials with management training.

Although the housing co-operatives are currently functioning to a certain degree in both constituencies, the degree to which these co-operatives will be able to further replicate the technology in the construction of more teachers' houses is dependent on three key factors the skills of the co-operative officials, access to finance, and management capability. In terms of skills, the future construction of teachers' houses will require that the co-operative officials be able to carry out the following tasks: plan future projects and estimate their cost, order building materials, prepare site and house plans, acquire land, secure long-term finance, engage contractors, account for project funds, and provide periodic supervision at the project site. However, depending on the arrangement with the local artisans for the construction of more teachers' houses, the artisans may be able to assist with tasks like estimating costs and ordering building materials.

However, it appears as though there is a need in both constituencies for a co-operative manager who is more conversant with the technical aspects of house construction such as estimating the cost of future projects, ordering building materials, and preparing site and house plans. The existing co-operative officials may be able to perform these tasks, but because of their lack of past experience in carrying out such tasks, they may not be able to perform them efficiently. Inefficiency in performing these tasks could prevent the co-operatives from building the maximum number of houses with the funds available to them.

In terms of finance, the housing co-operatives generate income from three major sources: rent from the tenants in the existing teachers' houses, membership dues from those who join the co-operatives, and the sale of shares in the co-operatives. In the future the co-operatives also hope to generate income from the sale of soil-cement blocks and sisal-cement sheets to private individuals.

Since the income generated by the sources mentioned above has not yet been significant, both co-operatives continue to be constrained by lack of finance. But according to the earlier analysis of reasonableness of costs to the housing co-operatives, it appears as though the income generated through the collection of rent, in itself, will eventually be sufficient to finance the construction of more teachers' houses. Any additional income generated from membership dues, the sale of shares, and the sale of building materials will simply add to the total amount available for investment in new teachers' houses. The finance generated from these latter three sources can also be used to maintain the houses.

In terms of management capability, there are several factors which indicate that the existing co-operatives may lack the skills required to efficiently manage the construction of more teachers' houses. Although the co-operative in Bunyala has been able to find occupants for five of the six houses, it has not been as successful in fulfilling other responsibilities. First, the reason that one of the houses at Makunda has not yet been occupied is because it is not yet finished. In the seven months since the Bunyala housing co-operative assumed control of the houses, it has not yet been able to complete a house that was already 90% complete at the time it assumed control.

Second, the co-operative has been slow in responding to maintenance requests from the tenants. Third, the co-operative has not yet been able to negotiate the transfer of its present bank account in Nairobi to the nearest local banking facilities in Siaya. Fourth, although there are approximately 6000 families residing in Bunyala location,[20] the co-operative has only succeeded in motivating about 230 individuals to join. Fifth, when the roofs of the houses started leaking in April and May of 1986, the co-operative's immediate response was to seek assistance from HRDU rather than to try to solve the problem themselves. However, in late May the co-operative began to look for an alternative solution on their own which indicated that they were beginning to realize that they were responsible for solving their own problems. Sixth, the housing co-operative has not yet managed to pay some wages that have been outstanding since October of 1985.

Given that the Bunyala housing co-operative is in the process of electing new co-operative officials and transferring its bank account and other administrative functions from Nairobi to Bunyala, some of the above comments may be a bit premature. However, they do serve as preliminary indicators that the co-operative may lack some of the skills required to efficiently manage future construction activities.

The management capability of the housing co-operative in Mbita division will continue to be limited until the conflict between society members is resolved. In fact, this conflict has prevented the co-operative from carrying out any further activities. Only the houses at Lambwe primary school have been occupied.

Summary

In summary one can say that generally the technology satisfies most of the criteria for replication, and thus, should be replicable in Bunyala and Mbita. Locally, the people view the technology as being an acceptable alternative to conventional housing. In terms of appropriateness, the technology is suitable for the local climate, makes maximum utilization of the local labor force, and except for the use of cement and timber, relies predominantly on building materials that are readily available in the study area, thus reducing some of the transport costs normally associated with the use of conventional building materials. The cost of the technology is not reasonable for an average family in the study area, but it is reasonable for some private individuals, community organizations, and the housing co-operatives.

Because of the technology's acceptability, appropriateness, and reasonable cost; there is currently a demand in the study area for the technology and hence potential for its replication. However, its replicability seems to rest on the capability of local individuals and local organizations, such as the housing co-operatives, to supply the demand. The technical skills for its replication are currently present in the study area; but the housing co-operatives, as the primary institutions responsible for replication, may require some reorganization before they can effectively and efficiently coordinate future construction activities. One of the major constraints to future replication continues to be lack of finance.

From the preceding evaluation of project effectiveness and efficiency one can conclude that the IRT project was not nearly as successful as had originally been anticipated. Although the projects' end products, i.e. the teachers' houses, are quite satisfactory; the process of obtaining them was affected by many problems. Despite the many problems encountered during the implementation process, one can still conclude that the use of improved indigenous building materials such as stabilized soil-cement blocks and sisal-cement roofing sheets can significantly reduce the costs of house construction and yet maintain a high standard of housing quality. However, this particular project was not a good demonstration of how the use of local labor in the construction process can reduce house construction costs.

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Introduction

The purpose of this chapter is to present a summary of the major findings from the preceding chapter. These findings form the basis for identifying the key lessons learned from the evaluation of project effectiveness and efficiency. Because this chapter presents only a summary of the findings, the reader must refer to the preceding chapter for the details.

Project Effectiveness

The evaluation of project effectiveness measured the degree to which the IRT project actually attained its original purposes and objectives. From the evaluation one can conclude that the original project purpose of transferring appropriate low cost housing technology to the people in Bunyala and Mbita has been partially achieved. The technology has been transferred to approximately 40 individuals in each constituency. However, the degree to which the technology is low cost is debatable, but one can conclude that it is approximately 26-40% cheaper than conventional technologies.

The second project purpose of establishing a mechanism through which the technology can be further replicated has also been partially achieved.

The housing co-operatives, which are the primary institutions responsible for replication, have been established in each constituency. However, the degree to which they can effectively and efficiently coordinate future construction activities remains to be seen. By June of 1986 they had not yet replicated the technologies in any way.

The major findings with respect to the achievement of project objectives are presented below.

Units Completed, Cost, and Time

The first project objective was to construct twelve demonstration housing units at a construction cost of approximately Kshs.48,000 per unit and within a time period of 48 weeks. In reality, ten housing units were completed at a construction cost of approximately Kshs.103,000 per unit and within a time period of two years and eight months.

Employment and Income Generation

The second project objective was to create employment and generate income for those who would be directly involved in the production of building materials and construction of the housing units. It was expected that skilled workers would learn about the new technologies, improve their existing skills, and improve their economic welfare. It was expected that unskilled workers would benefit only in terms of learning about the new technologies; they were to provide labor freely.

This project objective was fulfilled to an even greater extent than had originally been expected. Because of the decision to pay unskilled workers for their efforts, both skilled and unskilled workers benefitted in terms of employment, increased incomes, and acquisition of skills which can be utilized to generate additional income in the future.

Accessibility to the Target Population

The third project objective was that the demonstration houses would be accessible to primary school teachers. If accessible, it was expected that the teachers would benefit in terms of reduced transport costs to and from school, improved housing conditions, and increased productivity in teaching.

This project objective has been almost fully achieved. Most primary school teachers in Bunyala and Mbita, including those with lower professional qualifications such as P2s and P3s, can afford to rent the IRT housing units. In fact, of the seven houses which are currently occupied, five are occupied by teachers. At Lambwe primary school in Mbita division the teachers chose not to live in the IRT housing units. Consequently, the houses have been occupied by a local pastor and some people working for the Lake Basin Development Authority. One house at Makunda primary school and both houses at Nyamuga primary school are not yet occupied.

The teachers who are residing in the five houses in Bunyala have benefitted in terms of the time savings resulting from the fact that they no longer have to travel long distances to school each day. Because they spend less time travelling they now have more time to prepare lessons, mark assignments, and supervise other school activities. Consequently, they are able to teach more effectively and it is in this respect that their pupils benefit.

In terms of housing conditions teachers who had previously been teaching in Bunyala or another rural area indicated that they have experienced an improvement in their overall housing conditions. However, teachers who had previously been teaching in an urban area and living in a house built with conventional materials such as cement, concrete blocks, and galvanized iron sheets indicated that the overall quality of their housing conditions has remained about the same. The latter response indicates that these teachers find houses built with improved indigenous building materials to be an acceptable alternative to conventional housing.

Replication

The fourth and final project objective was to enable the local communities in Bunyala and Mbita and other schools in these areas to replicate the technology in the construction of shelter and other community facilities. This project objective has been partially achieved. Although the housing co-operatives had not yet replicated the technology in any way by June of 1986, there are two private individuals in Bunyala who have already used soil-cement blocks and sisal-cement roofing sheets in further construction activities.

Efficiency of Project Implementation

From the evaluation one can conclude that many difficulties encountered during the implementation of the IRT project severely limited the efficiency of the implementation process. Beneficial results were not as significant as expected, and costs were higher than expected.

Evaluation of efficiency focussed on the two components of the house construction process which can significantly lower the cost of house construction to a more affordable level, that is, the technology and community participation. In order to assess the degree to which these components have affected the efficient implementation of the IRT project, four key indicators of efficiency were considered: speed of implementation, cost, quality, and replicability. The major findings and lessons learned from the examination of these indicators are presented below.

Speed of Implementation

Although there were minor delays in project implementation resulting from the technology aspect of the IRT project, it was learned that most of these delays can be held to a minimum through proper planning. It was only the one to two month delay resulting from the inadequate supply of cement and timber that substantially affected the speed of project implementation. But even this delay was not entirely the fault of the technology. Rather, it was as a result of the retendering process and the inaccessibility of the sites during the rainy season.

The major delays in project implementation were a result of the community participation aspect of the project. In fact, the major reason for the minimal progress during the first 16 months of the project can be directly attributed to the reluctance of the local community to provide unskilled labor on a self-help basis. This reluctance was the result of several factors. First, at the beginning of the project the people in Bunyala and Mbita were suffering through a prolonged drought which had resulted in a famine throughout the area. Second, the project had to be stopped for one month due to Parliamentary General Elections. Third, the housing co-operatives never did become fully operational in Bunyala and Mbita during the course of the project. Consequently, the main organizations responsible for mobilizing the local people were not able to take an active role in project implementation and management. Fourth, some local leaders never understood the purpose of the project and thus were not able to clearly explain the project objectives to the people, especially concerning the provision of self-help labor and the ownership of the houses. Fifth, even if the housing co-operatives had been fully operational at the local level from the beginning of the project, it is not likely that they would have been effective in carrying out their responsibilities since they never received any training in how to manage a housing project.

Other reasons for slow implementation resulting from the community participation aspect of the project included the following: inadequate on site supervision resulting from long distances between the five project sites, cash-flow problems from the financing agency to the implementing agency, loss of building materials due to damage by rain, and occasional unavailability of skilled artisans when they were needed. However, after HRDU stationed a project supervisor on site and the decision was made to pay unskilled workers, the speed of implementation increased significantly.

From the findings presented above several lessons were learned. First, for effective community participation it is critical that the local community identify with the project as their own, as something that is initiated by themselves and for themselves. If they see the project as something that is being done for them by the assisting agencies, they will be reluctant to participate. Second, project participants must be accurately informed about the relevant features of the proposed project and the conditions of their participation. Third, it is important to make sure that an effective community organization (e.g. a functional housing co-operative) exists before starting the project, one that can mobilize the local people. Fourth, continuous on site supervision is necessary to ensure that those employed are working when they are supposed to be. Fifth, critical socio-economic and locational considerations have to be examined during project design. This will enable choice of manageable sites, incorporation of priorities and roles of various agencies and local people's aspirations and values.

Cost

In the IRT project it was the cost of labor, not the cost of building materials, that contributed most significantly to the 110% increase in the total cost of each housing unit. Of this 110% increase, 81% can be attributed to the increased expenditure on labor while only 29% can be attributed to the increased expenditure on building materials.

The actual expenditure on building materials, skilled labor, and unskilled labor exceeded the planned expenditure. The actual expenditure on building materials was 16.6% higher than planned. The amount paid to skilled labor was 352.5% higher than had been expected. Although unskilled labor was to have been provided by the local people on a self-help basis, the actual amount paid to unskilled workers was approximately Kshs.186,500, was nearly equal to the amount paid to skilled labor, and accounted for 18% of the total cost of each housing unit.

The 16.6% increase in the cost of building materials can be attributed to two major factors: (1) the delays in project implementation and the resulting increase in the cost of building materials over time and (2) the need to use more than double the amount of cement initially expected. The substantial increase in the amount of cement used in the project was a result of wastage, variations in the original design of the houses, and the failure of the hydraulic component of the "Brepak" machine to function properly at three project sites.

The increase in labor costs over what had initially been planned can be attributed to three major factors: (1) the delays in project implementation and the resulting increase in the cost of labor over time, (2) the need to pay unskilled workers, and (3) the low level of productivity of both skilled and unskilled workers resulting from inadequate on site supervision and the method of paying workers. Instead of accounting for 8% of the total cost of each house as originally expected, the cost of labor actually accounted for nearly 39% of the total cost of each housing unit which is even higher than the 27.5% figure normally associated with the formal contractor-built method of house construction.

Despite the large amount of material wastage in the IRT project, the cost of an IRT housing unit per m^2 was still 26% lower per m^2 than the same housing unit constructed with conventional building materials.

From the preceding findings several lessons were learned. First, the use of improved indigenous building materials can significantly lower the cost of house construction. Second, continuous on site supervision is necessary to minimize material wastage. Third, the use of local labor will not always reduce the cost of house construction. Its success in reducing costs depends on other factors such as the degree of on site supervision and the method of paying workers. Fourth, when on site supervision is inadequate, the method of paying skilled and unskilled workers on a daily basis, rather than on the basis of performance, results in low worker productivity. Fifth, local community participation in project implementation is not automatic, especially when project participants can be more profitably employed elsewhere.

Quality

The high overall quality of the IRT housing units can be attributed to both the technology and community participation aspects of the project.

In terms of the technology, soil-cement blocks and sisal-cement roofing sheets were found to compare quite favorably with the properties of conventional building materials such as fired bricks, concrete blocks, asbestos-cement sheets, and galvanized iron sheets. In some respects (e.g. noise absorption and comfort of interior environment) these materials perform even better than conventional building materials.

It was also discovered that soil-cement blocks and sisal-cement sheets satisfy the performance standards of the Grade I By-laws in the Kenya Building Code. However, since the code is not based on performance criteria alone but also specifies which building materials are acceptable for wall and roof construction, the omission of soil-cement blocks and sisal-cement sheets from the list of acceptable materials renders them unacceptable for use in Kenya's urban areas.

User satisfaction with the technology was also found to be quite high. The only questionable aspect of the technology is the durability of the materials over time.

In terms of the community participation aspect of the project, despite inadequate on site supervision, the overall quality of all ten houses is quite high.

The high quality of both the building materials themselves and the way in which they were assembled can be attributed to several factors. First, the site foremen for the IRT project were taken to Nairobi for a three-week training course pertaining to the production and use of soil-cement blocks and sisal-cement roofing sheets. Second, the project supervisor from HRDU demonstrated to the unskilled workers at each site how to produce these materials. Third, during his monthly visit to the site the project supervisor checked to ensure that the quality of the materials being produced was acceptable. Fourth, skilled artisans were involved in the construction of the houses. Fifth, the techniques for assembling soil-cement blocks and sisal-cement sheets are similar to conventional construction techniques and thus, the skilled artisans quickly adjusted to the small variations. Sixth, the project supervisor tried to schedule his site visits so that he could be on site whenever critical tasks like pouring the floor slab were carried out.

From the preceding findings on quality several lessons were learned. First, improved indigenous building materials such as soil-cement blocks and sisal-cement sheets satisfy the performance standards of the Grade I By-laws in the Kenya Building Code. Second, in a project like this where new technologies are being introduced to unskilled workers, it is critical that proper training in materials production and construction techniques be provided by an experienced technical person. Third, the involvement of skilled and unskilled workers from the local area in the house construction process did not have a negative effect on the overall quality of the houses. However, when building materials are produced and stored on site it is important that unskilled workers take proper precautions in the production, curing, and storage of building materials. Fourth, the production of improved indigenous building materials on site is a relatively simple process and can be transferred to a group of previously unskilled workers in two to three weeks. Fifth, periodic supervision by an experienced technical person is sufficient for maintaining an acceptable standard of quality in the production and use of soil-cement blocks and sisal-cement sheets.

Replicability

Generally, the technology satisfies most of the criteria for replication, and thus, should be replicable in Bunyala and Mbita. Locally, the people view the technology as being an acceptable alternative to conventional housing. As long as the use of the technology is limited to rural areas in Bunyala and Mbita, it will receive support from both the local people and government officials. But if its use is proposed in the urban areas of these constituencies, it may meet some resistance from the local authorities.

In terms of appropriateness, the technology is suitable for the local climate, makes maximum utilization of the local labor force, and except for the use of cement and timber, relies predominantly on building materials that are readily available in the study area, thus reducing some of the transport costs normally associated with the use of conventional building materials. However, the use of the "Brepak" block press for making soil-cement blocks is not the most appropriate choice because of its high cost, local unavailability,and frequent breakdowns.

The original idea of using a combination of skilled and unskilled labor in which unskilled tasks were to be performed by members of the local community on a self-help basis was appropriate given the financial resources available. However, the degree to which this approach will be replicable in future projects will depend on the make-up of the local community and the manner in which the project is introduced to them. If the local community is reluctant to contribute unskilled labor freely, the housing co-operatives may have to pay unskilled workers. However, if the labor costs in future projects are as high as they were in the IRT project, the technology may not be worth replicating.

The cost of the technology is not reasonable for an average family in the study area, but it is reasonable for some private individuals, community organizations, and the housing co-operatives. In fact, if the co-operatives manage their finances efficiently, they should be able to build additional houses solely on the basis of rent collected from the existing units.

Because of the technology's acceptability, appropriateness, and reasonable cost; there is currently a demand in the study area for the technology. In fact, two private individuals in Bunyala have already initiated projects using the same technology; and other individuals, institutions, and the housing co-operatives have expressed interest in further utilizing the technology in the construction of houses, classrooms, and even some small hotels.

Although the demand exists, the replicability of the technology seems to rest on the capability of local individuals and local organizations, such as the housing co-operatives, to supply the demand. The technology was successfully transferred to both skilled and unskilled workers in the study area. Thus, the housing co-operatives have access to the skills necessary to enable them to continue with the construction of more teachers' houses in the future.

But the housing co-operatives, as the primary institutions responsible for replication, may require some reorganization before they can effectively and efficiently coordinate future construction activities. In particular, the co-operatives lack the technical knowledge to carry out such tasks as estimating the cost of future projects, ordering materials, and preparing site and house plans. The failure of the Bunyala housing co-operative to complete one house at Makunda and its slow response to maintenance requests from tenants indicate that it may not be fully capable of coordinating future house construction. Until the conflict between co-operative society members in Mbita is resolved, that co-operative will remain ineffective.

From the preceding findings on replicability several lessons were learned. First, demonstration projects are successful in convincing members of the local community that improved indigenous building materials provide an appropriate alternative to the use of conventional building materials in house construction. Second, government officials and local authorities may be reluctant to approve the use of the technology in urban areas. Third, because of the need, though small it may be, for cement in the production of soil-cement blocks and sisal-cement sheets, these building materials may not always be the most appropriate choice for a given location. It is always best to use materials that are readily available. Fourth, the housing co-operative approach to building teachers' houses was a new concept in the study area. Thus, local people had little confidence in their management and operations, especially during the initial stages of the project. However, the successful completion of the IRT project has generated more confidence and co-operative membership is increasing. But the local people seemed to have trouble identifying with the co-operative at a divisional level. That is part of the reason for the existing conflict in Mbita. Fifth, for successful project replication it is just as important to provide the housing co-operatives with management training as it is to provide skilled and unskilled workers with technical training in materials production and construction techniques.

Introduction

Based on the findings and lessons learned from the evaluation of the effectiveness and efficiency of the IRT project, the purpose of this chapter is to present recommendations that will enable the housing co-operatives in Bunyala and Mbita to further replicate the technology in the construction of more teachers' houses.

Since the management committees of the housing co-operatives currently have very little experience in managing house construction, it is recommended that the initial stages of the replication process be kept as simple as possible until the co-operatives gain some additional experience. It seems as though simplicity can best be achieved by following the method of house construction that the local people are already familiar with, i.e. the method which was introduced in the IRT project.

The recommendations fall into seven main categories: (1) organization of the housing co-operatives, (2) financing of future house construction, (3) site selection, (4) selection of the technology, (5) materials production, (6) method of house construction, and (7) house design.

Recommendations

Organization of the Housing Co-operatives

In terms of the organization of the housing co-operatives the following recommendations are made:

(i) that the management committee of each co-operative be composed of representatives from each administrative location in the division so that people in all locations will feel as though they are represented at the divisional level, thus see the potential to benefit from the activities of the co-operative, and hence support its activities. This balance in representation can be achieved through the following measures:

- A first election is held in which the chairman, vice-chairman, secretary, and treasurer are selected by the co-operative members. However, it is recommended that no more than two of the elected officers should be from any one location. After the initial election, up to four locations from the division may be represented. From this point two options are suggested for ensuring that all locations are represented on the management committee:

  . that a second election is held in which two representatives from each of the remaining locations are selected by the co-operative members or

- that the elected officers appoint two representatives from each location.

(ii) that all elected officers and representatives be responsible for telling people about the potential of the new technology and mobilizing people in their respective locations to support the co-operative, become members, and buy shares. Consequently, it is recommended that local leaders such as chiefs, assistant chiefs, and headmasters be included in the management committee.

(iii) that elected officers and representatives reside in their local constituency on a full-time basis. From the IRT project it was learned how unsuccessful a housing co-operative can be in carrying out its responsibilities when the registered officers reside outside the constituency.

(iv) that the management committee rely on existing organizations in the division such as the SPAs to coordinate activities at the local level. To create conditions which are favorable for the construction of teachers' houses at their respective schools the SPAs should be responsible for the following:

- acquiring the necessary land on which to build the houses.
- mobilizing the local people to perform unskilled tasks on a self-help basis.
- actively participating in the site selection process so that they know what is expected from them.
- encouraging the local people to join the co-operative.

(v) that the management committee exercise discretion in assigning additional responsibilities to the SPAs besides those mentioned above. For example, where the SPA is strong, additional responsibilities can be assigned.

(vi) Since the elected officers and representatives will in most cases be volunteers with other full-time responsibilities, it is recommended that the co-operative in Mbita hire a full-time manager who can coordinate its daily activities, but this should not be done until the conflict is resolved.

(vii) that the managers of both co-operatives be able to carry out the following responsibilities:

- plan future house construction that corresponds to the needs and financial capacity of their respective co-operatives. This will have to be done in conjunction with the management committees, but as the hired professional, the manager should be able to suggest alternative plans for replication and how they can be implemented.

- acquire and maintain the necessary tools and equipment.

- prepare site and house plans, especially in the long run.

- sequence and schedule building stages.

- estimate the number of man-hours required for each stage of construction.

- estimate the cost of materials for each stage, order the required materials, and arrange for their transport to the site.

- engage skilled artisans from the local area to be responsible for daily on site supervision, materials production, and actual house construction.

- provide periodic on site supervision to ensure that all aspects of construction progress smoothly.
- ensure proper use and storage of materials, tools, and equipment.
- collect rent from the tenants.
- arrange for proper maintenance of the houses.
- respond to the tenants' requests and complaints.

If the managers do not possess the skills needed to carry out these responsibilities, it is recommended that they attend a short training course on house construction management.

(viii) that in the short term the managers work closely with the skilled artisans in the area who were involved in the IRT project. It is the artisans who know how many soil-cement blocks are required to build a house of a given size, how many blocks can be produced with one bag of cement, and other similar information which is important in estimating costs and ordering materials.

(ix) that the following responsibilities be carried out by the management committee as a group:

- selection of sites for future house construction in conjunction with SPAs.
- selection of the most appropriate technology for each site.
- plan future house construction with the assistance of the manager and SPAs.
- engage in the monitoring and evaluation of co-operative activities in order to improve the planning of future projects and to take corrective action to improve existing projects.

(x) that the co-operatives find out what assistance is available from the National Co-operative Housing Union (NACHU), especially in terms of co-operative training.

(xi) that the co-operatives continue to seek assistance from HRDU on technical matters that cannot be handled by the co-operatives in conjunction with assistance from local artisans. But as long as the co-operatives continue to approach future house construction in a similar manner to the IRT project, they should be able to solve most of their own problems.

Financing

In terms of financing the following recommendations are made:

(i) that the co-operative in Bunyala use the funds generated through the collection of rent from the existing tenants to complete the unfinished house at Makunda, that the co-operative in Mbita resolve the conflict between society members as soon as possible, and that both co-operatives then find tenants for all of the unoccupied rooms. By filling the houses completely they will be able to maximize the amount of rental income collected each month.

(ii) that the co-operative in Bunyala transfer its bank account in Nairobi to a local bank as soon as possible and that both co-operatives get the houses appraised so that they can use their existing assets to obtain loans with which to build more teachers' houses.

Site Selection

In terms of site selection the following recommendations are made:

(i) that the site selection process be carried out by the management committees in close conjunction with the SPAs to find out what the local people would be willing to contribute to the implementation of the project.

(ii) that site selection be based on objective criteria such as:

- the willingness of the local people to perform unskilled tasks on a self-help basis, to contribute land on which the houses can be built, and to become members of the co-operative.

- the physical accessibility of the site. Sites that are easily accessible facilitate fast project implementation and thus keep the costs of house construction at a minimum.

- the type of soil. Some types of soil will not be suitable for soil stabilization.

- the relative need for teachers' housing.

- physical characteristics of the site such as slope, amount of vegetation, and wind direction.

The use of objective criteria tends to remove some of the political bias normally associated with such decisions.

(iii) that teachers' houses first be built at one site in each administrative location of the division. This will help people throughout the division to become aware of the technology and enable them to actually see the quality of houses built with improved indigenous building materials.

(iv) that the initial site selected in each administrative location be located along the main roads or near the market places where the local people can easily see the houses in person.

(v) that in the short term the management committee strongly consider the selection of sites where soil tests have already been performed by HRDU. However, it is important that these sites also satisfy most of the criteria mentioned above.

(vi) for sites where the soils have not yet been tested, that the tests continue to be performed by HRDU. Since the technology is still somewhat experimental in nature, it is important that no mistakes are made in the proportions of soil and cement added to the soil-cement mixture. Otherwise, the soil-cement blocks produced may not meet acceptable standards for compressive strength, durability, and percentage water absorption rate.

(vii) that the criteria be weighted by the management committee on the basis of the local situation. For example, although it is important that the site be easily accessible, sometimes the dire need for teachers' housing at a particular school may override all other criteria.

(viii) that the willingness of the local people to participate in project implementation be one of the most important criteria in selecting any site, especially during the early stages of the replication process when finance is limited.

Selection of Technology

In terms of selecting the technology the following recommendations are made:

(i) that the management committee strongly consider using soil-cement blocks and sisal-cement roofing materials in the future construction of teachers' houses. However, they must realize that this is just one alternative and may not be the most appropriate choice at all sites. It is always best to use whatever materials are locally available, inexpensive, and of acceptable quality.

(ii) that the Cinva-Ram soil block press be used for future block production because of its low cost, local availability, ease of repair, and its ability to produce blocks having more than sufficient strength for one-storey house construction. Although Cinva-Ram machines are being produced in Kakamega, Murang'a, and Machakos; the quality control has not been good and thus, it is recommended that the co-operatives purchase the improved Cinva-Ram that is being manufactured in Nairobi for about Kshs.9000.

(iii) that in the short term the co-operatives continue to use sisal-cement sheets as a roofing material since the initial capital investment is low and the local people are already familiar with the production process. However, sisal-cement pantiles are the preferred roofing material because of their superior visual appearance, light weight, small size, and easy method of attachment. But the initial capital investment is somewhat substantial. As the co-operatives acquire more capital and start building teachers' houses on a larger scale, it is recommended that they start manufacturing and using the sisal-cement pantiles.

Materials Production

In terms of materials production the following recommendations are made:

(i) Since HRDU retained the "Brepak" soil block presses after completion of the IRT project, each co-operative should consider purchasing at least one Cinva-Ram machine and preferably two so that if one breaks down, block production can continue with the other.

(ii) that the co-operatives continue to produce soil-cement blocks and sisal-cement sheets at the construction site, especially during the early stages of the replication process. It is much easier to transport two Cinva-Rams to a new project site than it is to transport the 8,000 blocks and 280 sisal-cement roofing sheets required to build two teachers' houses which are exactly like those constructed during the IRT project.

(iii) that in a situation where the members of the SPA are willing to produce soil-cement blocks and sisal-cement sheets on a self-help basis the following suggestions be considered:

- that a group of about five to ten people be selected to carry out each task to its completion. Such an arrangement minimizes the amount of time that the site foreman must spend training people, and it helps to maintain proper quality control.

- if it is not possible for such a group of people to commit themselves to such a task for 30 to 40 working days, it may be necessary to utilize a larger number of groups of local people with each group volunteering to work for a specific number of days. In such a case the following recommendations apply:

  - At the beginning of materials production a large meeting should be held for all people who are interested in helping, during which the site foreman will introduce the process of making soil-cement blocks and sisal-cement sheets to the entire group so that when they appear on site they will have at least a general idea of what is expected of them.

  - The co-operative should hire two people who can be at the site daily to instruct, supervise, and take part in the production of building materials; thus ensuring consistency in the quality of the materials produced by many different groups.

(iv) that in a situation where the members of the SPA are reluctant to produce materials on a self-help basis the following suggestions be considered:

- that the co-operatives hire the individuals who participated in the production of soil-cement blocks and sisal-cement sheets during the IRT project.

- that payment be based on output to encourage high daily rates of production.

- that the manager or site foreman establish a certain quality standard which the workmen must maintain. If the quality drops below the minimum standard, the co-operative will not be obligated to purchase those building materials.

(v) that workers take proper precautions in the production, curing, and storage of building materials in order to minimize material wastage.

(vi) that the manager or site foreman plan ahead so that the materials produced have fully cured by the time they are needed. For example, the soil-cement blocks should be produced while the site is being cleared, the foundations are being dug, and the slab is being poured. And the sisal-cement sheets should be produced while the walls are being built and the roof structure is being fixed in place.

Method of Construction

In terms of the method of construction the following recommendations are made:

(i) that the housing co-operatives continue to utilize local labor. There is no need to hire a formal contractor for house construction, especially when the local artisans are already familiar with the building materials and construction techniques.

(ii) that the co-operatives continue to hire the skilled artisans who participated in the IRT project. If those particular artisans are not available, it is recommended that the co-operatives employ people who have been trained at the local youth polytechnics.

(iii) that skilled artisans be paid on a contract basis, that is, a lump sum to carry out their respective roles in the house construction process. Such a method of payment should promote fast implementation and thus keep the project costs to a minimum.

(iv) that close on site supervision by an experienced skilled artisan be provided at each project site to minimize material losses and ensure that both skilled and unskilled laborers are working when they are supposed to be.

House Design

In terms of house design the recommendations are as follows:

(i) that in the short term the co-operatives continue to use the same basic floor plan and most of the details that were used in the IRT project since both the local artisans and the co-operative manager in Bunyala are already familiar with this approach.

(ii) that the ridge detail presented in Figure 6.1 be adopted in future house construction to prevent leaking at the ridge joint.

(iii) that in the long run the co-operatives find out what the teachers like or dislike about the design of the houses and then incorporate their suggestions in the design of future houses.

(iv) as an area of further research, that someone examine how the floor plan and roof structure of the IRT housing units can be altered to provide the soil-cement block walls with greater protection from the rain. One may want to examine variations on the design of the traditional house in which the walls were short and the roof eaves projected

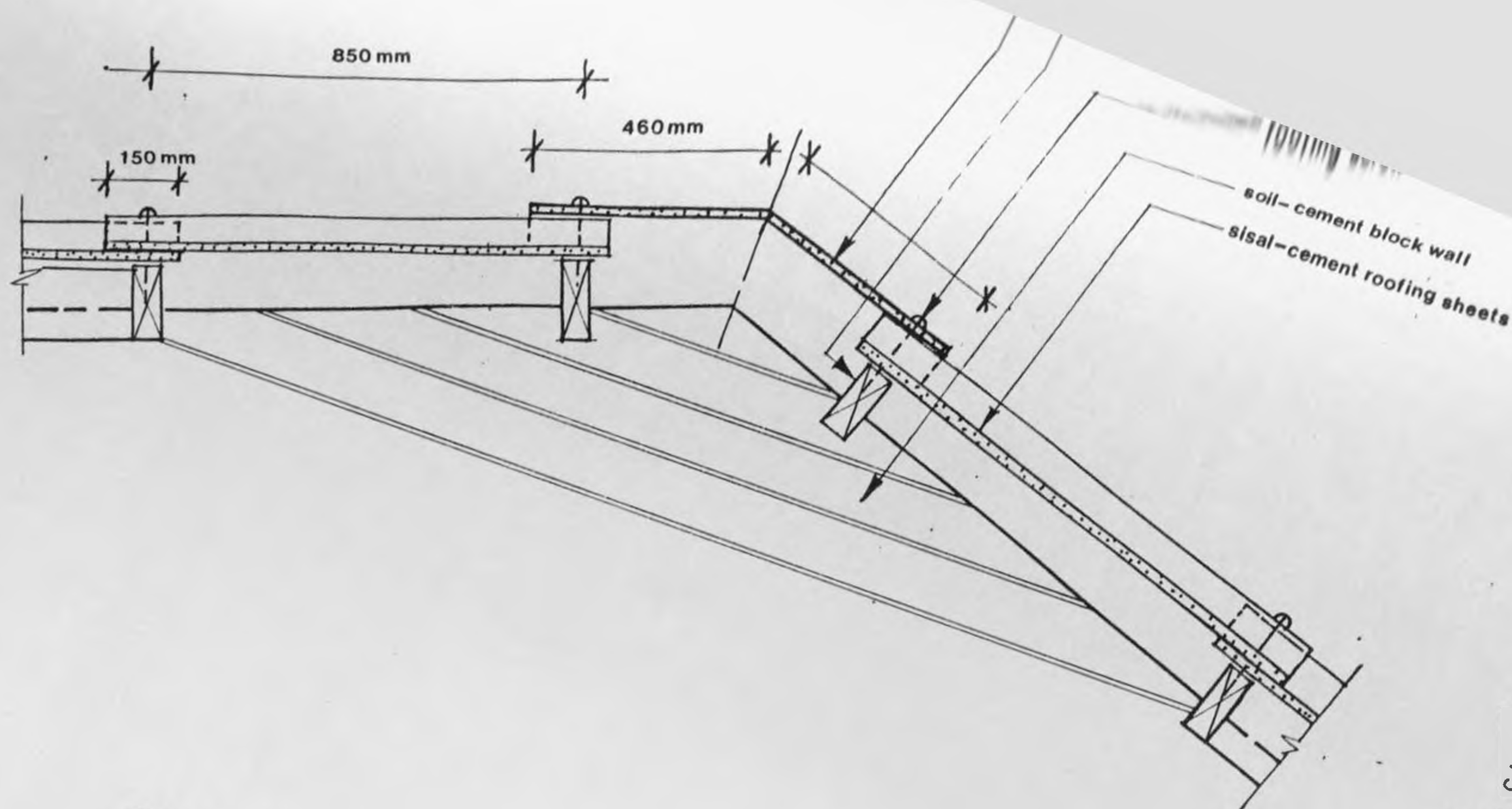

FIGURE 6.1: RECOMMENDED DETAIL OF RIDGE JOINT

out beyond the walls on all sides of the house to protect the mud-and-wattle walls from the rain.

Summary

The replication of the technology in the construction of more teachers' houses rests on the abilities of the housing co-operatives in Bunyala and Mbita. Since little technical assistance is available in the short term, it is recommended that the replication process be kept as simple as possible and rely primarily upon resources already available in the study area and the methodology of house construction introduced through the IRT project since it is this method that the co-operatives, managers, skilled artisans, and unskilled workers are already familiar with. Since the management committees of the co-operatives currently have very little experience in house construction, it is recommended that in the short term they work closely with the skilled artisans, especially during the initial attempts to replicate the technology.

In order to reduce the cost of labor that was so high in the initial phase of the IRT project, it is recommended that where possible the co-operatives should work together with the SPAs to mobilize local people to carry out unskilled tasks on a self-help basis. But where this is not possible, it is recommended that unskilled workers involved in materials production be paid on the basis of output, and skilled artisans should be paid on a contract basis, that is, a lump sum to carry out their respective roles in the house construction process. Such arrangements should ensure close supervision, promote fast implementation and thus keep the total cost of future replication activities to a minimum.

CONCLUSION

According to past and present National Development Plans the need for housing in Kenya's urban and rural areas is growing at a faster rate than it can be satisfied. This growth can be attributed to many different factors including limited national resources, rising costs of house construction, high building standards in urban areas, no real improvement in household incomes, and limited use of appropriate alternatives to conventional housing. In fact, the rising costs of house construction can be attributed directly to the rising costs of building materials and labor which account for nearly 82% of the total cost of a conventional housing unit.

The basic hypothesis of this study has been that the total cost of house construction can be decreased significantly through the use of improved indigenous building materials and construction techniques and local community participation in the construction process, hence contributing to the provision of housing which a larger percentage of the people in Kenya can afford. This hypothesis has been tested through an evaluation of a rural-based demonstration housing project in Western Kenya, a project which addressed itself specifically to lowering the cost of house construction through the use of improved indigenous building materials and local community participation.

From the evaluation of the project it was learned that local community participation is not automatic. In fact, since the local people were reluctant to perform unskilled tasks such as materials production on a self-help basis, the decision was made to pay unskilled workers. This decision in conjunction with the low productivity of both skilled and unskilled workers resulting from inadequate on site supervision resulted in a total project expenditure on labor that was nearly 8.5 times higher than had originally been expected. Hence, the cost reduction normally associated with the involvement of local people in the house construction process on a self-help basis never materialized in this particular project.

Despite the many problems encountered in the community participation aspect of the project, it was learned that the use of improved indigenous building materials such as soil-cement blocks and sisal-cement roofing sheets can reduce the costs of conventional house construction by approximately 26% and yet maintain a high standard of housing quality. In fact, one of the most positive aspects of the project was that the local people now view the technology as being an acceptable alternative to conventional housing.

The future replicability of the technology in Bunyala and Mbita seems to rest on the capability of local individuals and local organizations, such as the housing co-operatives. If the co-operatives can successfully address themselves to the recommendations presented in Chapter 6, they will be able to continue to build more teachers' houses with improved indigenous building materials and construction techniques and hence fulfil the original objectives of the IRT project.

The cost of this particular technology may prevent it from reaching the lowest income groups in Kenya, but it does provide an appropriate alternative for a larger percentage of households which cannot afford conventional housing but still desire housing of a high quality. Although the introduction of this technology on even a nationwide basis will not totally alleviate the need for housing in Kenya, it will certainly make a significant contribution toward reducing that need.

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