RURAL HOUSING IMPROVEMENT IN GHANA.

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ABSTRACT

The traditional housing practices of rural Ghana are discussed and three inherent problems - poor construction methods, the unavailability of affordable modern building materials and poverty - are investigated in detail. Previous attempts at improving rural housing by research institutions, the Government of Ghana and international agencies, are examined.

A number of methods based on building walls which are waterproof and strong enough to resist the elements in the tropical climate, are proposed. Additional criteria for these methods are affordability and the local availability of building materials. Improved production and construction methods should be easily understood by the rural population.

The construction methods investigated are: rammed earth, soil-cement, brick and sun-dried earth block construction (with lime as a stabilizer). Methods for the production of these materials are also described.

The author concludes that to achieve improvements in rural housing in Ghana, the rural population would have to be involved in all stages. These include the production of building materials as well as house construction.

RESUME

Cette thèse étudie les structures traditionnelles du logement dans les régions rurales du Ghana, en les trois principaux problèmes qui s'y rattachent -- les piètres méthodes de construction, la difficulté de se procurer aisément les matériaux modernes de construction, ainsi que la pauvreté. Elle examine aussi les tentatives antérieures faites par des institutions de recherches, le gouvernement du Ghana et des agences internationales pour l'amélioration du logement rural.

Diverses methodes sont proposées quant a l'élévation de murs à l'épreuve de l'eau et suffisamment résistants aux éléments naturels du climat tropical. La disponibilité et les moyens d'obtenir les matériaux de construction au niveau local s'avèrent des critères additionnels. La population rurale devrait mieux comprendre les mthodes de construction et de production.

Les méthodes étudiées sont la terre battu, le terre/ciment, la construction en blocs de terre séchée au soleil ou la brique (avec la chaux comme stabilisateur), en plus la façon de produire ces matériaux.

Pour conclure, l'auteur explique que la population rurale devrait s'impliquer dans tous les phases afin qu'il y ait une amélioration dans le logement rural au Ghana. Ces phases comprennent la production des matériaux de construction aussi bien que la construction des maisons elles-mêmes. Les méthodes de construction et de production devrait être mieux compris par la population rurale.

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PART 1

CHAPTER 1

INTRODUCTION

1.1 SIGNIFICANCE AND PURPOSE

"The rains poured down for days and for weeks; the floods came, and not in a small way. Houses at Nsutam began to collapse, and the life of the people was threatened. The local dailies began the cry on behalf of the people of Nsutam, the cry was continued by the village folk, asking the Government of Ghana to 'come over to Macedonia' to help" (1). This statement was recorded by Abloh in "Nsutam Report, A Settlement Study", in 1974. After the end of the rainy season of 1970, the full impact of the rains had begun to sink in. Several villages in the Tropical Rain Forestland, including Nsutam, had been literally wiped out by the rains. This scenario which was gradually establishing itself as an annual affair, had reached one of the worst proportions in 1970. Several villages in the Mampong district of the Ashanti Region, particularly Krobo, had also been destroyed. An entire modern township was built for the people of Krobo, probably because the Head of State at that time happened to be a native of the village.

In "Planning for the Neglected Rural Poor in Ghana", Kodwo Ewusi records that in the village of Kwamoso in the Tropical Rain Forestland, most of the respondents in a survey complained that the floor of their houses became flooded after heavy rains (2). This suggests that the building materials and construction technology employed in rural Ghana do not permit durable houses.

These examples could be described as only the tip of the iceberg. Many villages in rural Ghana have seen, and continue to see, the collapse of houses, particularly during the rainy season from April to August each year. A routine reaction to this annual occurence appears to have been evolved over the years. After the cries for help, both the central government and other organizations move in with aid which varies from food rations to building materials. The amount of aid offered and the speed with which it is despatched to the disaster area do not follow any laid down procedure. They can at best be described as arbitrary. Thus while Krobo village had a whole new township in modern building materials with wide streets lined with lights within two years, the people of Kwamoso complained bitterly through their Village Development Committee about unfulfilled promises by government officials (3).

The problems posed by poor construction methods and the unavailability of modern building materials remain. Many rural dwellers still dream about the day they can build houses like those in the urban centres but continue to live in partially collapsed houses. There is therefore a need to initiate measures to improve rural housing in Ghana.

Brown gives the following reasons to support the need for rural housing improvement in Ghana "...the rural people constitute 71.1% of the total population, provide about 70.3% of the labour force, produce about 98% of food crops and 60%

of industrial raw materials for agro-based industries, contribute over 96% of the agricultural export produce, earn over 60% of the country's foreign exchange, and constitute the main source of the country's income generation" (4).

There has never been a consistent policy for a nation-wide rural housing improvement. Whatever has been done in the name of rural housing improvement has been characterized by spotty, unrelated and sometimes irrelevant investment on an adhoc basis. Such sporadic, disjointed and uncoordinated efforts have hardly made any impact on the rural housing situation. Rural people who are the target group of rural housing improvement efforts are left out of the formulation, planning, assessment of local needs, and the implementation of the programmes. The result is portrayed in the New Nsutam housing development scheme, for example, in which many of the completed houses are uninhabited. Recent rapid changes of government have further jeopardized the situation.

What is the present rural housing situation in Ghana ? What forces have shaped this ? And how can these forces be tackled ? These are some of the questions to be addressed in this thesis, whose purpose is to review the rural housing situation in Ghana and examine possibilities for improvement.

1.2 LIMITATIONS

The United Nations (U.N.) classification for an urban centre is any settlement with a population of 20,000 or more. This means that any settlement with a population below 20,000 qualifies to be called rural. However, for the purposes of this thesis, the term rural will refer to settlements of about 5,000 or less, since according to the Ghanaian Population Census of 1970, only settlements below 5,000 were classified as rural (1).

This thesis focuses on the wall elements of the rural house, that is, the foundation, the wall itself, and the openings up to the roof. It will, however, discuss how rural housing has been constructed over the years, as well as the gradual infiltration of modern construction methods into the rural areas. Sanitation and communal facilities such as public buildings, community centres, markets, post offices, etc., will not be considered. Only methods which allow rural dwellers to actively participate in their housing improvement and which are economically feasible are examined in this thesis. As far as possible, solutions are based on the availability of local materials. The thesis indicates what needs to be done and further discusses in detail what methods and materials are to be used.

1.3 SCOPE

The thesis is divided into three main parts: a description of existing rural housing in Ghana, the factors which have contributed to the problem, and measures to improve this situation. The existing rural housing situation is documented on a regional basis related to climate and supported extensively by a detailed graphic account. Issues which are considered here as factors contributing to the existing rural housing situation are poor construction techniques, the unavailability of modern building materials, and poverty.

1.4 PROCEDURE

The third part of this thesis deals with measures to improve the situation, considered here to have four guiding principles:

1). The measures should be simple enough and financially affordable to the rural people.

2). They should allow the active involvement of the rural people in terms of planning, design, implementation and maintenance.

3). They should allow the use of improved, locally-available building materials and appropriate construction techniques.

4). They should allow for small-scale village industries to permanently sustain rural housing improvement.

Influenced largely by these principles, measures to be considered for rural housing improvement in Ghana consist basically of various techniques to improve earth construction. These include building construction in burnt clay bricks, soil-cement blocks, sun-dried earth bricks and blocks, and rammed earth construction. For cementitious stabilizers, lime is the most preferable because large deposits of limestone are available throughout the country. Small-scale village methods of production are to be utilized for the production of the building materials.

All these measures involve some methods of financing, however, direct central government financial involvement in the form of loans and outright grants is not advocated by this thesis. Instead, government-funded vocational training schemes in the rural areas are preferred. Rotating savings and loans associations (locally known in Ghana as "susu") are favoured in the rural areas, to build upon a system which is already widespread in West Africa. These associations are proposed to open up credit facilities in the rural areas. New Rural Banks are also expected to play a role in rural housing improvement financing. Some efforts which had been carried out in rural housing improvement by government agencies and research institutions had been labelled "low-cost". It is suggested that in fact these developments were not affordable to the rural dwellers. The measures proposed by this thesis qualify to be classified as intermediate or appropriate technology methods which can be afforded by the rural population.

FOOTNOTES

1. Central Bureau of Statistics, <u>Population Census of Ghana, 1970</u> C.B.S., Accra, 1970

2. F.A. Abloh et al., <u>Nsutam Report, A Resettlement Study,</u> H.P.R.D., U.S.T., Kumasi, 1974.

3. Kodwo Ewusi, <u>Planning for the Neglected Rural Poor in Ghana,</u> New Times Corp., Accra, 1978.

4. <u>ibid.,</u>

5. C.K. Brown, "Towards A Meaningful Approach to the Organization of Rural Development in Ghana", <u>Ghana Journal of Sociology,</u> Vol.10 No.1 Accra, 1976, (pp.32-41)

CHAPTER 2

EXISTING RURAL HOUSING IN GHANA

Existing rural housing practices in Ghana have been greatly influenced by three main factors, namely climate, available local materials and traditional family patterns. A fundamental characteristic of the climate in Ghana is the mass of tropical continental air - warm and dusty - which extends from the Sahara Desert to the Atlantic coast. This has had an important influence on traditional housing development in Ghana, which for the purposes of this thesis, will be divided into three zones: the Northern Savanna, the Tropical Rain Forestlands (or the South-Western and Ashanti Areas), and the Coastal Savanna (or the South-Eastern Areas) as shown in Fig. 1 (1).

The Northern Savanna is hot and dry, with intermittent rainfall between March and September, and a drought period of 4 - 6 months with an average rainfall of about 40 inches in about 3 months. The climate and vegetation is of the typical tropical savanna type. Further south is the Tropical Rain Forestland. This area is hot and humid with annual rainfall varying from over 80 inches in the extreme south-west to 55 - 60 inches in the other areas. A tropical rain forest predominates here and it is an important timber producing area. The flat Coastal Savanna is warm and dry, with two rainy seasons separated by two fairly dry spells in July and August, and a longer one from December to February. Relief features around this part of the country produce rain shadow effects, and the vegetation of this area is sparse, comprising mainly palm and coconut trees and savanna vegetation with an annual rainfall of under 35 inches.

The three broad climatic divisions influence existing rural housing in Ghana in terms of the availability of local building materials. Whereas earth is found in all the three regions, timber is abundant in the Tropical Rain Forestland but scarce in both the Northern and the Coastal Savanna. Consequently, timber is not extensively used in traditional building in the Savanna belts. Again, while bamboo is plentiful in the Tropical Rain Forestland, it is thatch which was abundant in the other two climatic belts, although thatch is now getting relatively scarce in the Savanna regions. Furthermore, whereas the availability of palm trees has resulted in the use of woven or plaited palm fronds in the Coastal Savanna, that practice is non-existent in the Northern Savanna.

The housing responses to these climatic divisions are as follows: thick earth walls to resist the heat in the Northern Savanna with either flat earth roofs or thatched conical roofs. Monolithic earth construction and timber framework with earth infilled walls and pitched roofs to protect the building fabric from the rains in the Tropical Rain Forestland. Woven or plaited palm frond walls which allow through ventilation in the hot and dry atmosphere with pitched thatch roof are found in the Coastal Savanna. Table 1 below shows the building materials utilized for construction in the three climatic regions.

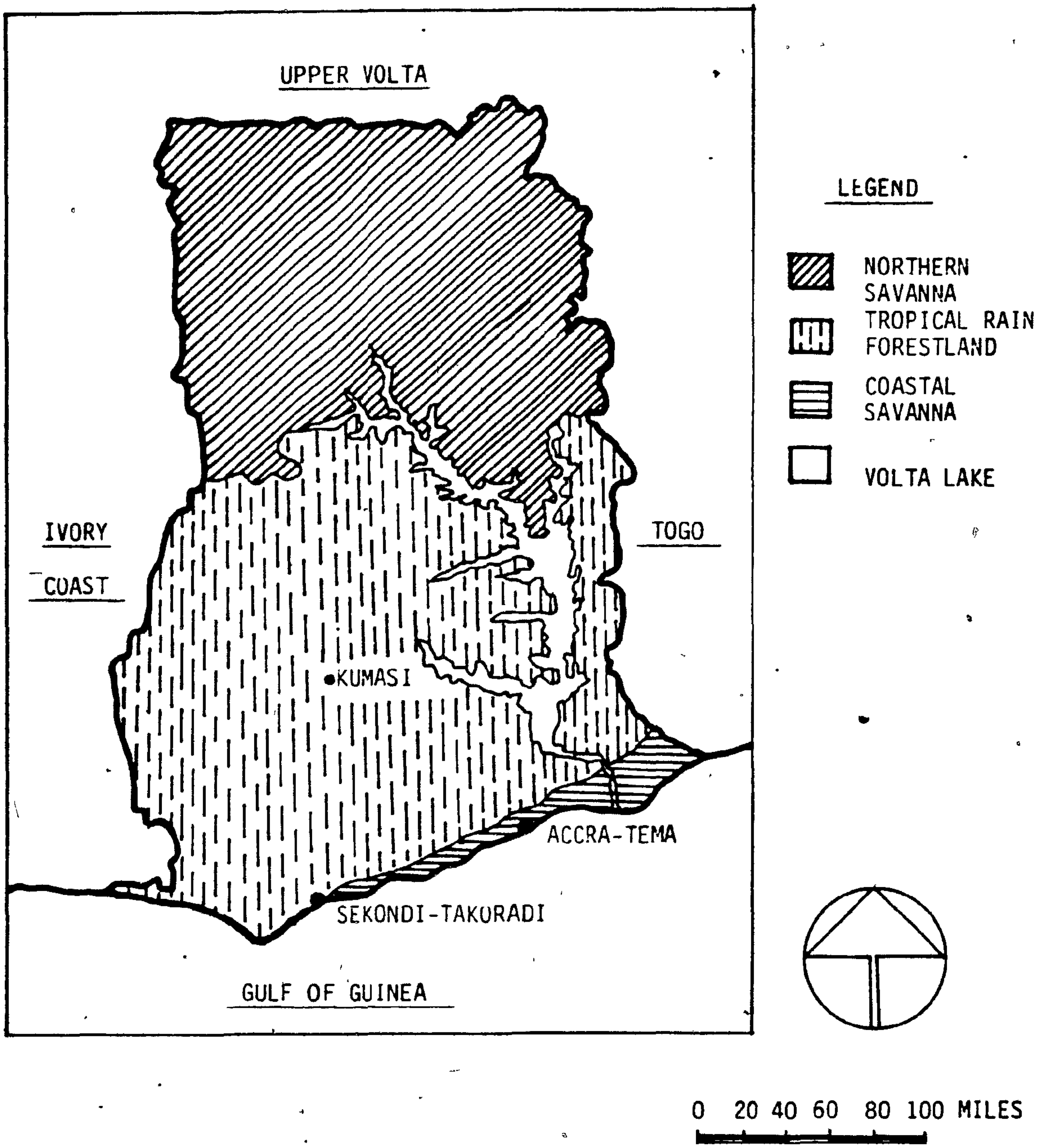


FIG.1 MAP OF GHANA SHOWING THE THREE MAIN CLIMATIC ZONES.

Table 1

Building Materials utilized for construction in the three Climatic Regions

	Northern Savanna	Tropical Rain Forestland	Coastal Savanna
Foundation	None	Earth	None
Walls	Monolithic Earth.	Monolithic Earth. Wattle and daub (timber frame-work with earth infilling).	Bamboo or timber framework with woven or plaited palm frond infilling.
Roof	Conical thatch or flat earth roof over timber framing.	Pitched thatch or bamboo slats (but corrugated galvanised iron and aluminium sheets recently)	Pitched thatch or bamboo slats.

Traditional family patterns in Ghana differ from those in North America and Europe. A family in Ghana includes both the nuclear and the extended types, and various combinations of the two. Family patterns include the husband and wife (or wives) and children; there may also be two or three dependants such as nephews, nieces or servants as part of the household. There also exist families where the wife lives apart from the husband with her own family (in the case of matrilinear inheritance) so that the children would be looked after by her brothers. Several of these family patterns are often found occupying one compound, but the members of a compound may not necessarily be a single economic unit, that is, members of a compound may not be supported by a common breadwinner or have a common budget. In such cases, the nuclear family and its dependants (for example the husband's widowed mother or a young unmarried brother) would form a separate household. A household therefore would be defined here, as a family (including the dependants) living in a compound as a single economic unit in which all the members are maintained by the head of the household.

In the Northern Savanna, although the traditional family structure is the same as in the south, the basic structure may comprise only brothers and their wives and children, or larger groups related patrilinearly. The man is the head of the compound, everything belongs to him and he is responsible for his large family socially, as well as economically, unlike in the south. When a son gets married, he is allowed to stay in the compound by adding his dwelling unit and an entrance of his own. Thus the compound house in the Northern Savanna grows by accretion (Fig. 2).

The basic social structure as described above has resulted, over the years, in a communal pattern of living. For the various households to live together comfortably in a hot tropical climate, a large enclosed yard is required where residents can gossip, do their housework, and even work at their trades. In this type of tropical climate, it is always more comfortable to be outdoors in a dry weather. The courtyard therefore has become the centre of life, especially where there are shade trees.

2.1 NORTHERN SAVANNA

This area covers about 40% of the total area of the country. The warm and dusty mass of tropical continental air strongly influences this part of the country and is clearly reflected in the housing development.

2.1.1 Traditional Dwelling Types

The traditional dwelling form and spatial planning in this case, as in all the others, have evolved from the household activities and the relationship between indoor and outdoor spaces. A typical traditional house is the compound house, and as the name implies, it is basically a house of several dwelling units around an enclosed courtyard. The compound house has a plan which is dictated by a socio-economic stucture produced by a communal living pattern and by the geographical conditions which determine the availability of natural traditional building materials such as thatch and mud. Together, these have determined the form and construction techniques utilized in the erection of the houses.

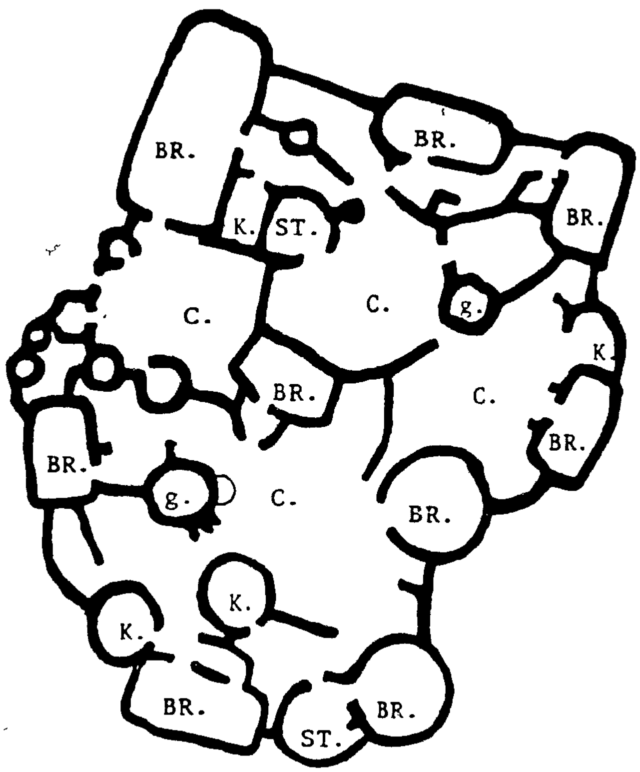
The Northern Savanna compounds are distinct in their development and plan form. There are two types - the circular and the rectangular. The two types however, both produce arrangements which result in a maze of huts. Semi-circular or rectangular walls enclose a series of courtyards which have distinct functional areas such as a male courtyard, female and children's courtyards, and a courtyard for storage of grains and domestic animals (Fig. 2 and Fig. 3). A typical circular courtyard compound has an area of about 4000 square feet while a typical rectangular one, more compact, covers an area of about 3000 square feet. This is the roofed area. The layout of the Northern Savanna settlement is generally of the nucleated type but there are also some dispersed settlements with scattered and isolated dwelling units in the farmlands (see Fig. 7).

2.1.2. Construction Techniques

Before construction starts, the site is prepared (weeded or cleared of any vegetation) and the outline of the dwelling unit marked on the ground. The wall positions are marked on the ground with either a pointed edge or ash from the cooking areas. The construction technique utilized in the Northern Savanna belt is monolithic "swish" construction. Swish consists of a mixture of clay-earth and water. Construction commences early in the dry season when water is still available in the pools and ditches of the low-lying areas adjacent to the building sites.

Clay for the mixture is dug usually from an adjacent hillside. A foundation is rarely made for this type of construction and the swish mixture is used to erect the monolithic thick walls in layers, with the thickness of the

CROSS-SECTION THROUGH CIRCULAR COMPOUND.



LEGEND.

BR. - bedroom.
K. - kitchen.
C. - courtyard.
ST. - storage.
g. - granary.

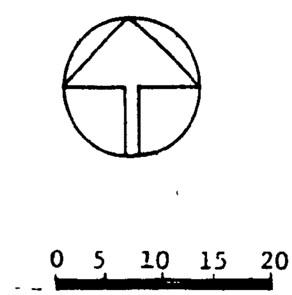
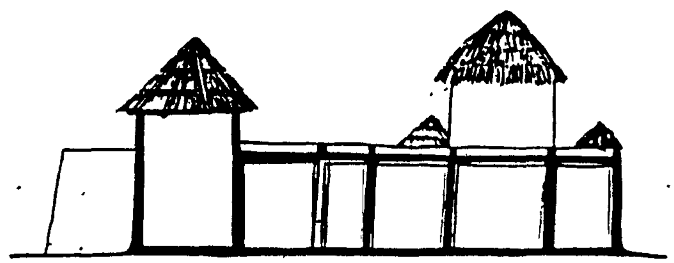


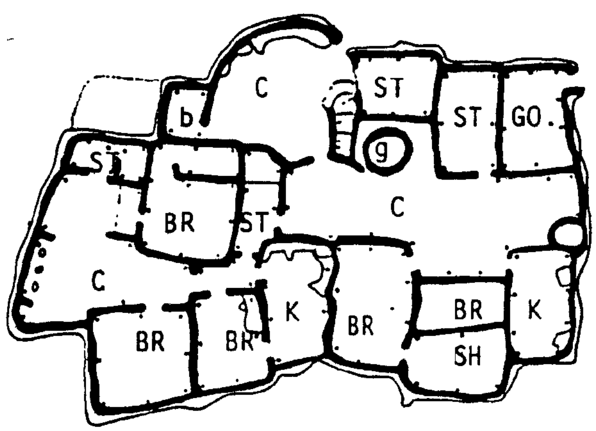
FIG. 2 NORTHERN SAVANNA - CIRCULAR COMPOUND TYPE.



CROSS-SECTION THROUGH RECTANGULAR COMPOUND.

LEGEND

BR - bedroom.
C - courtyard.
K - kitchen.
ST - store.
g - granary.
SH - shrine.
GO - goats.



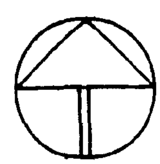


FIG.3 NORTHERN SAVANNA - RECTANGULAR COMPOUND TYPE.

0 5 10 15 20 FT.

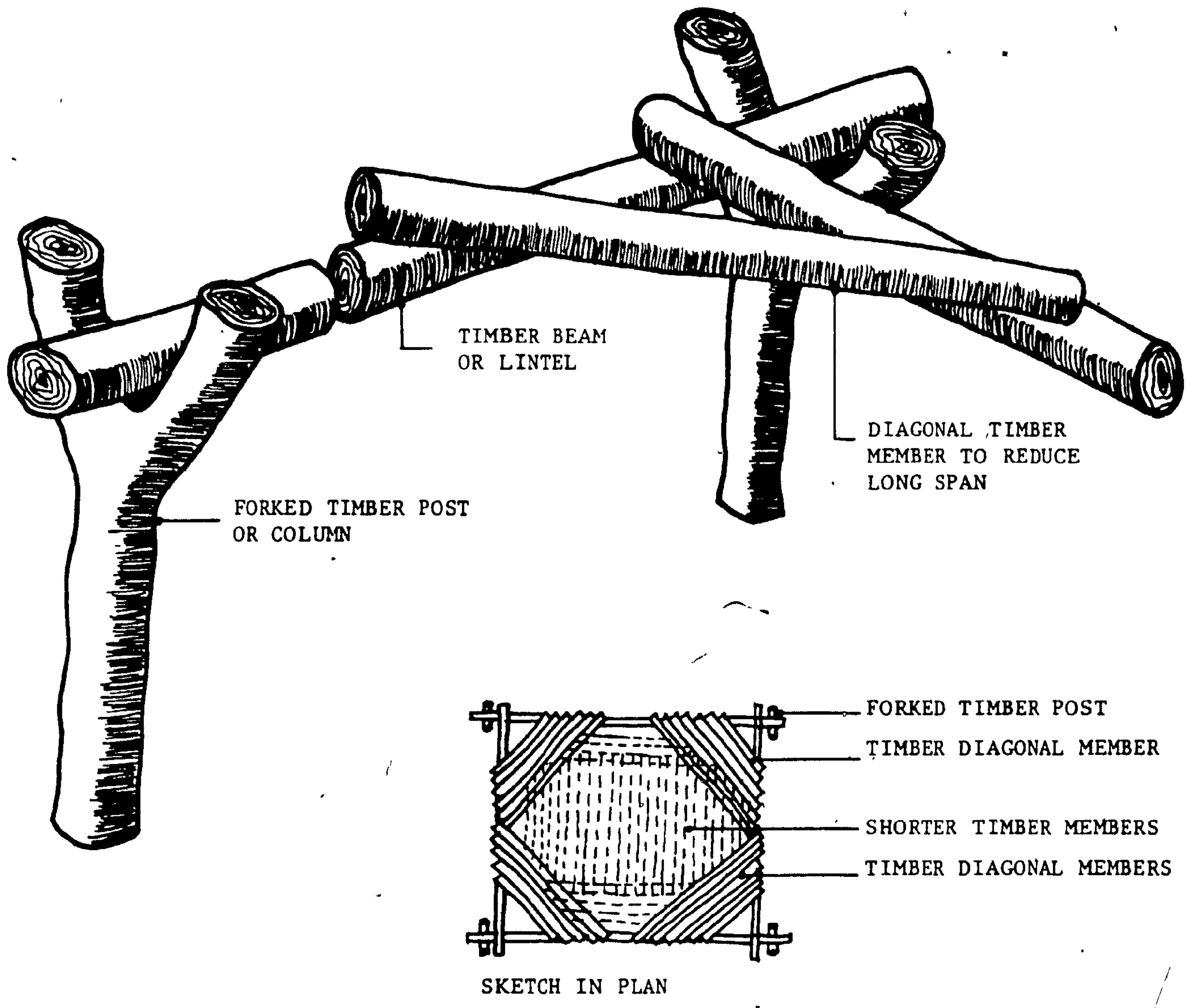


FIG.4 NORTHERN SAVANNA - SKETCHES ILLUSTRATING ROOFING DETAIL WHICH IS THE ANSWER TO THE ABSENCE OF LONG TIMBER MEMBERS.

walls varying from about 9 - 12 in. At a height of about 16 - 20 in., the owner-builder stops the construction process to enable the wall to dry up before the next layer is added. This process is continued until the owner-builder feels that the wall is high enough, usually about 7 feet.

In an alternative technique, the structure of the room units is built using a simple post-and-beam system, and each room is an independent structural entity. This is described in detail by Labelle Prussin in "Architecture in Northern Ghana" (2). Each room has a series of forked timber posts along its perimeter which carry the supporting beams for a dense layer of rafters (Fig. 4). This is an ingenious solution to the problem of the scarcity of long timber members to span the roof. The shorter timbers available are laid diagonally on the roof frame, and the now shorter span is bridged by the available shorter pieces. The mud walls here are not load-bearing, for the roof load is carried by the timber posts. Whether the walls are load bearing or not, openings (except doors) are very few and sometimes non-existent in this tapering, thick earth wall construction which is a direct response to the climate.

The floor is constructed of compacted earth to a height of about 6 in. above grade, and is finished together with the earth walls. Where the roof is flat, a mixture of cow-dung, pounded stem of plantain and banana leaves and water, produces a durable rendering material.

Two types of roof are utilized in the Northern Savanna the flat, earth-type, and the conical thatch roof. The flat

FIG.5 NORTHERN SAVANNA - VIEW OF A CLUSTER OF CIRCULAR COMPOUND HOUSES WITH FLAT EARTH ROOFS.

FIG.6 NORTHERN SAVANNA - VIEW OF A COURTYARD SCENE IN A CIRCULAR COMPOUND HOUSE WITH THATCHED CONICAL ROOFS.

FIG.7 NORTHERN SAVANNA - VIEW OF AN ISOLATED CIRCULAR COMPOUND HOUSE WITH THATCHED CONICAL ROOFS.

FIG.8 NORTHERN SAVANNA - VIEW OF A CLUSTER OF RECTANGULAR COMPOUND HOUSES WITH FLAT EARTH ROOFS AND PROJECTING EARTH PARAPETS ABOVE THE ROOF.

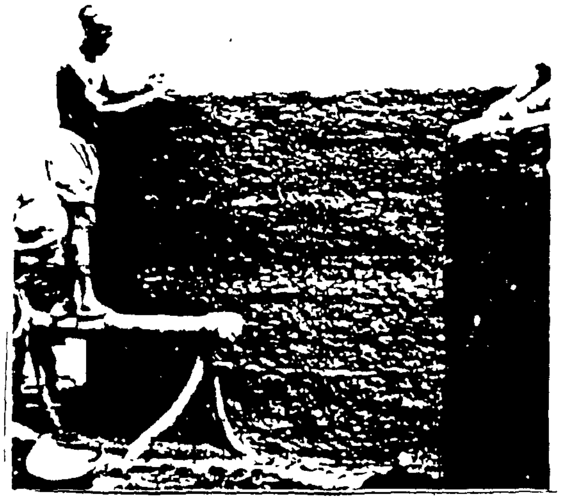


FIG.9 NORTHERN SAVANNA - WALL CONSTRUCTION IN PROGRESS. NOTE THE SUPPORT ON WHICH THE BUILDER STANDS.

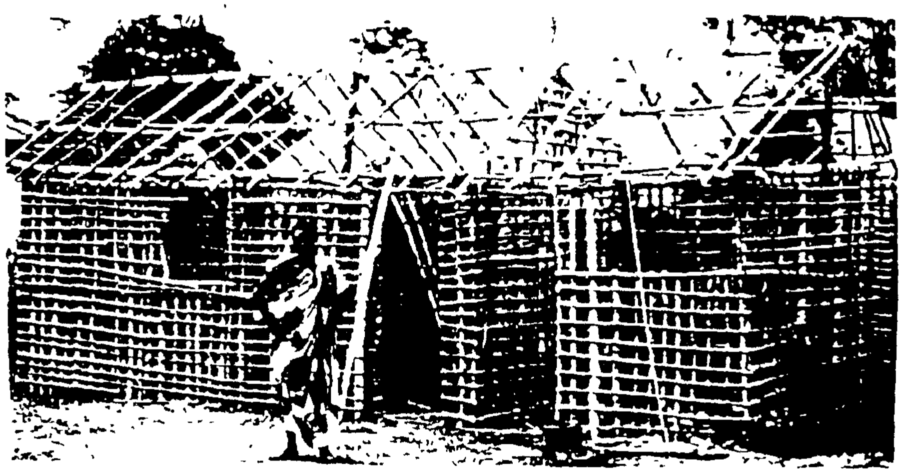


FIG.10 TROPICAL RAIN FORESTLAND - VIEW OF A COMPLETED TIMBER FRAMEWORK FOR WATTLE-AND-DAUB WALL CONSTRUCTION AND THATCH ROOF.

roof is supported by a dense layer of rafters, as has been described above (Fig. 4). This roof is usually about 6 inches thick and is clearly circumscribed by a projecting parapet about 12 in. high, formed by extending the walls beyond the roof itself (Fig. 5 and Fig. 8). The conical thatch roof has a timber substructure, tied together with twigs. The thatch is laid on the substructure and also tied with twigs, starting from the bottom upwards to the apex. Thatch roofs need to be maintained more regularly than the flat earth roofs. The thatch deteriorates faster and if not replaced more frequently, will leak. It is also worth noting that the granaries in the Northern Savanna compounds are usually roofed in thatch (Fig. 3 and Fig. 5). This is probably to allow light and air in them.

In this type of construction, hardly any building material is purchased by the owner-builder. This seems to be confirmed by Abrams who wrote "Virtually all building in the rural areas...was accomplished by self-help."(3). The whole process does not result in any financial outlay to the owner-builder as neighbours and relatives participate in the construction.

2.2 TROPICAL RAIN FORESTLAND

The area covered by this climatic belt is about 45% of the total area of Ghana. The Tropical Rain Forestland extends from the southern fringes of the Northern Savanna to the extreme south-western coastal areas of the country. The traditional dwelling type is the Ashanti-type compound house.

2.2.1 Ashanti Compound House

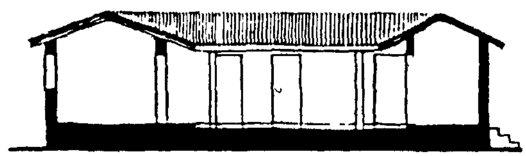
The traditional Ashanti compound house is a rough square in plan (Fig. 11). In its general layout, it has remained the same for centuries, but in recent years there has been a great increase in the construction of more modern houses, and the traditional compound house built of swish reinforced with a timber framework (also known as wattle-and-daub construction) is gradually disappearing. The plan form has not changed, however. It is being replaced by compound houses constructed of cement blocks with verandahs, and corrugated aluminium roofs (corrugated galvanised iron sheets had been widely used earlier on up to the 1960s). A typical Ashanti courtyard house as illustrated in Fig. 11 covers an area of about 1220 square feet. This does not include the open courtyard.

In both the towns and villages, the arrangement of compound houses have invariably conformed to a definite grid layout with streets, alleys and open spaces (Fig. 12).

2.2.2 Construction Techniques

A variety of construction techniques are employed for the construction of the Ashanti compound house. This is largely because of the tropical rain forest and the availability of a variety of building materials such as bamboo, timber and palm fronds. The predominant construction technique is wattle-and-daub, a more complicated process than monolithic swish construction.

The building site is cleared of any vegetation and an



CROSS-SECTION ACROSS ASHANTI COURTYARD HOUSE.

LEGEND

BR - bedroom.
ST - storage.
EL - entrance lobby.
SA - sitting area.
C - courtyard.
b - bathroom.
K - kitchen.

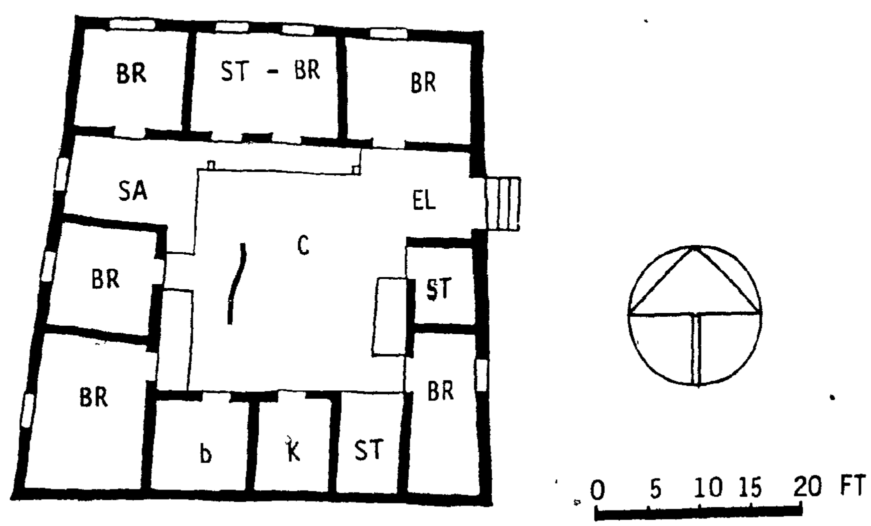


FIG.11 TROPICAL RAIN FORESTLAND - TYPICAL ASHANTI COMPOUND HOUSE.

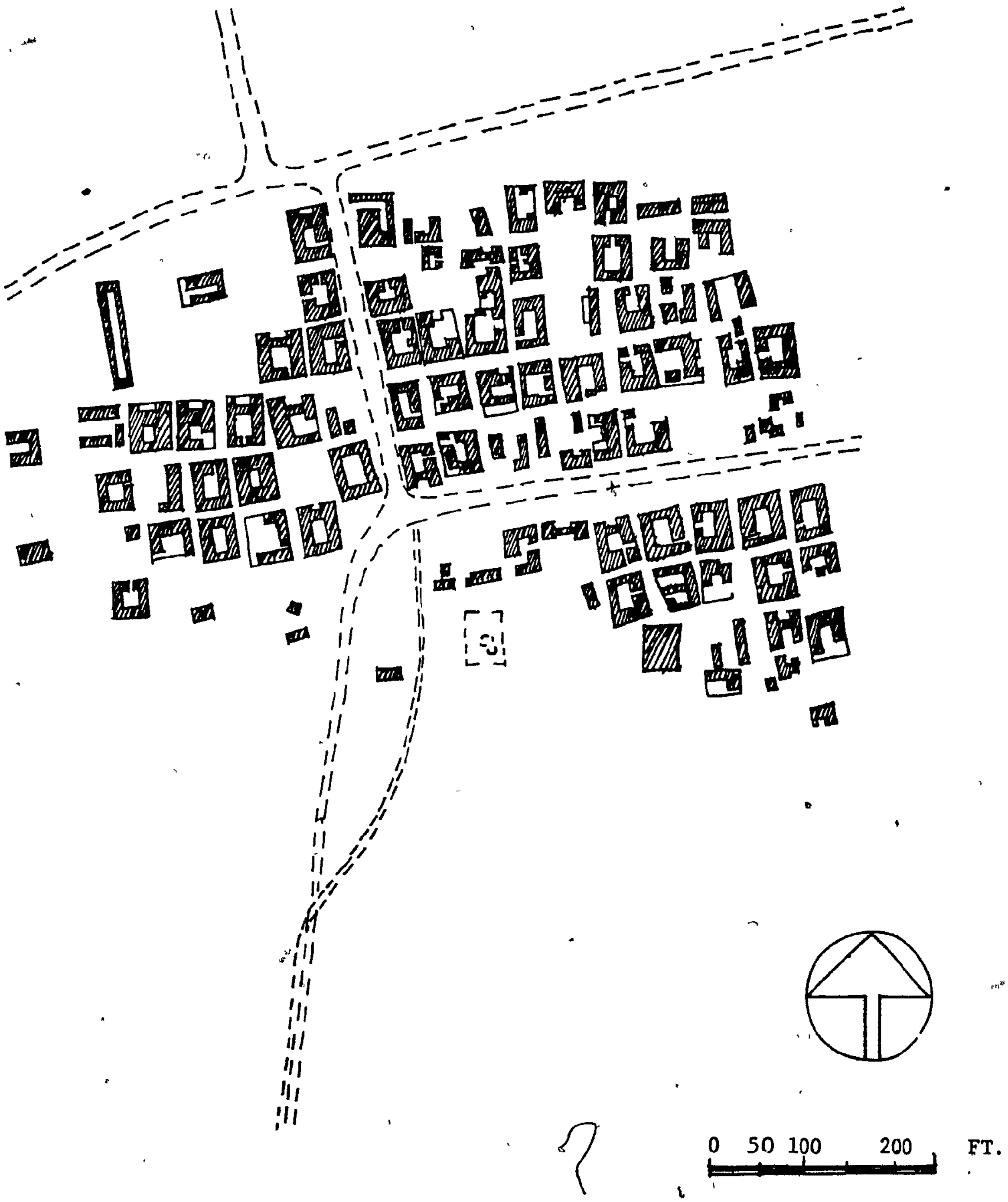


FIG.12 TROPICAL RAIN FORESTLAND - TYPICAL ASHANTI GRID IRON LAYOUT.

outline plan of the house is made on the ground, as has been described for the Northern compound house. A "foundation" is then constructed by compacting earth on the site, sometimes to heights of about 2 ft. above grade (Fig. 23). This, however, is not a universal practice as many dwellings have no foundations at all. Timber members are used to erect a framework, tied together by twigs, which also sometimes includes the substructure for the roof (Fig. 10). Openings for both doors and windows are left clear during the erection of the timber framework. Swish is then applied to both faces of the framework for the walls. Sometimes these walls are rendered with a liquid mixture of earth and water but it must be pointed out here that such a practice is not very common these days. The roof is always pitched to take care of the heavy rainfall experienced in this climatic belt. A variety of materials are employed for the roof but the most popular ones are thatch and bamboo slats (Fig. 19). It is not uncommon these days, however, to see some of these wattle-and-daub houses rendered in sand-cement plaster, and roofed with corrugated aluminium sheets. Except in cases where modern materials are used, (Figs. 16, 17 and 22), the only expenses incurred by the owner-builder would be the purchase of the timber doors and windows. Construction costs are also minimized as the house is constructed through self-help by the owner-builder, his family and neighbours.

2.3 COASTAL SAVANNA

This is the smallest of the climatic belts in Ghana, covering only about 5% of the total area of the country. The housing response to a dry and savanna-like climate is expressed in a lightweight construction of courtyard houses which are distinct because, unlike the other two house types, the various wings of the compound house are not physically joined together (Fig. 13).

2.3.1 Traditional Dwelling Type

In this type of compound house, it is not the rooms which enclose the areas where communal activities take place but rather the rooms themselves are inside an enclosed, walled compound. The factors that led to the development of this plan can be traced back to the traditional employment of the inhabitants of this area who are mostly engaged in fishing which results in a nomadic life because the fishermen move with the fishing season from one locality to another, up and down the coast. This itinerant life means that they are accustomed to living in less permanent shelters usually built of grass, palm leaves, bamboo and thatch; all materials which are readily available in the area. Traditional housing settlements among the people of this area are temporary and resemble camp grounds.

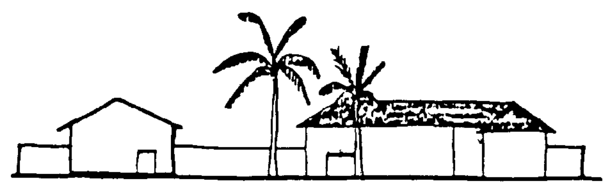
The compound house which evolved to meet their needs covers a large area, and is enclosed by a fence built out of palm fronds to act as protection for the temporary dwelling shelters. Each of these dwelling shelters is occupied by a nuclear family or children of the same parents; the compound covers an area of about 8000 square feet (this is the area enclosed by the fence wall). The layout resembles that of the typical Ashanti grid-iron pattern. In spite of the availability of modern and more permanent building materials, the general plan form of compounds in these areas has remained the same.

2.3.2 Woven Leaf and Thatch Construction

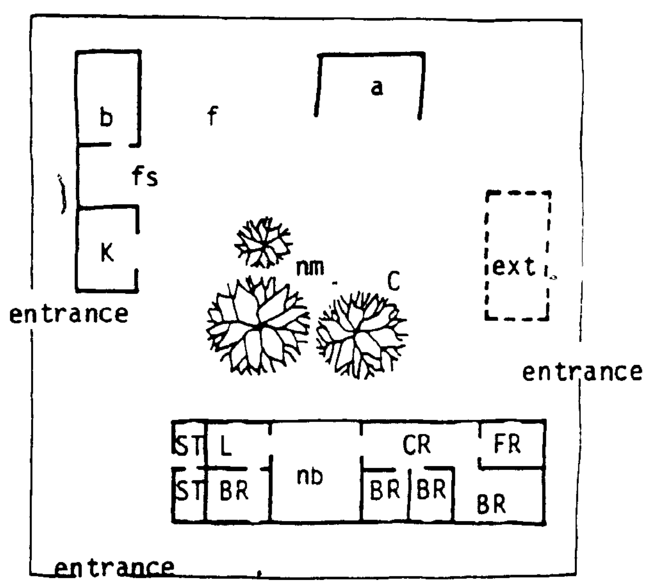
Compared to the other two regions, the woven leaf and thatch construction technique associated with the Coastal Savanna is the flimsiest; because of the nomadic life of the inhabitants the structures produced are temporary. Walling materials include grass, palm leaves and bamboos, and the roofing material is invariably thatch.

The building site is cleared and an outline plan of the dwelling unit marked on the ground. There is no foundation here, instead timber or bamboo members are driven into the ground and horizontal members tied to them to form a framework. Woven or plaited palm frond "wall panels" which can be rolled up, are then fixed to the framework by twigs. There is a floor of rammed earth which rises at most 2 - 3 in. The roofing material is usually thatch, though some bamboo ones also exist. Pitched roofs are the rule, with a timber substructure to take the thatch or bamboo (Fig. 14).

All the building materials are collected from the vicinity by the owner-builder. Construction is on a self-help basis with members of the owner-builder's family as well as neighbours assisting. Meals and drinks however, are provided by the owner-builder during the construction period.



CROSS-SECTION THROUGH COURTYARD HOUSE.



LEGEND

a - animals.
b - bathroom.
f - fishing net drying area.
nm- net mending area.
C - courtyard.
ext - future extension.
BR - bedroom.
L - living room.
ST - storage.
nb - night bathroom.
FR - fathers room.
CR - childrens room.
fs - firewood store.

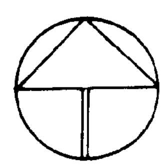
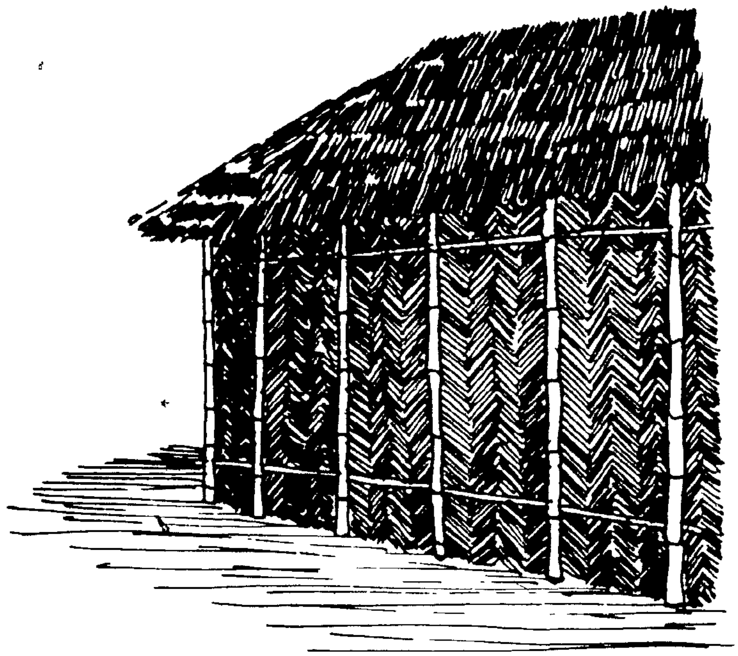
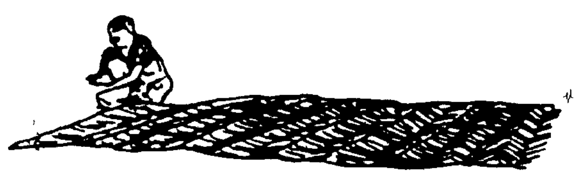


FIG.13 COASTAL SAVANNA - TYPICAL COURTYARD HOUSE TYPE.

0 5 10 20 FT.

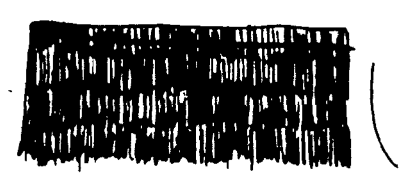


WOVEN HOUSE CONSTRUCTION



PLAITING WALL PANEL

WOVEN PALM FROND PANEL



ROOF THATCHING

ROLLED INTO BUNDLE TO FORM SHINGLE.

FIG. 14 COASTAL SAVANNA - WOVEN HOUSE CONSTRUCTION

Today, materials like thatch are relatively scarce and consequently more expensive. Modern methods of fishing has also resulted in higher incomes. As a result, many of these dwelling units are being replaced by more durable materials and permanent construction methods.

FOOTNOTES

1. J.A.K. Nutsugah, *Traditional Dwelling Formation As A Concept For Home Design.* C.R. No.12, B.R.R.I. Kumasi, 1977 (p.3)

2. Charles Abrams, *Man's Struggle For Shelter In An Urbanising World.* M.I.T. Press, Cambridge, Mass., 1966

3. Labelle Prussin, *Architecture in Northern Ghana, A Study of Forms and Functions.* University of California Press, Berkeley, 1969

CHAPTER 3

FACTORS THAT HAVE CONTRIBUTED TO RURAL HOUSING PROBLEMS IN GHANA

The various types of construction technology which have been practised over the years by indigenous people in the rural areas in Ghana have produced some problems in rural housing. The general problems are a high rate of deterioration of the houses stemming from the building materials utilized, and poor workmanship. The two main technical problems, however, are the lack of adequate foundations and the absence of solidity of the swish houses with resulting cracks developing along the corners. What causes these problems ? Three general causes will be discussed: poor construction techniques, the unavailability of affordable modern building materials, and poverty.

3.1 POOR CONSTRUCTION TECHNIQUES

One problem associated with rural housing is the result of the poor construction techniques used. In his report, "Housing Financing in Rural Ghana", Afele notes that, "..it could thus be stated that the failures in rural houses (swish houses) are due to two main factors, namely failures due to poor materials selection, and failures resulting from poor construction practices" (1). These failures have been manifested by two deficiencies: the lack of adequate foundations, and the absence of solidity of the swish houses, with resulting cracks developing along the corners.

Most rural houses have no foundations at all and the walls sit on the ground (see Fig. 27). What passes for a foundation in many rural swish houses is simply raised compacted earth. This is illustrated in Fig. 23. Rain action on these 'foundations' results in erosion and a weakening of the whole structure. Furthermore, in a tropical climate where sound roof construction is very essential, many rural houses in Ghana have poorly constructed roof substructures. In "Nsutam Report, A Resettlement Study", Abloh describes the flimsy structures which carry corrugated aluminium roofing sheets in the houses at Nsutam (2). Even though the aluminium roofing sheets are durable, the weak substructure results in a shorter lifespan for the roof as a whole. In addition to the problems of inadequate foundations and poorly constructed roofs, many rural houses of swish construction have several cracks developing around doors and windows. This is due to the use of undersized timber lintels. In "Nsutam Report, A Resettlement Study", note is taken of sagging 2-inch thick timber members used as lintels to carry monolithic swish walls (Fig. 17).

Most swish houses in the rural areas have walls which are not rendered. This is a problem, especially in the Tropical Rain Forestland where the rains are heaviest. The walls are exposed to rain action that leads to a rapid deterioration of the houses. According to Hammond, the main causes of deterioration of earth buildings are shrinkage cracks, erosion, under-scouring and mechanical damage (3). Most of these defects are due directly or indirectly to water and the effects of water on earth buildings have very often been totally destructive. If an earth wall becomes damp, it swells: on drying it shrinks and this results in cracks. A continuation of these drying and wetting cycles results in the enlargement of the cracks and the overall strength of the wall is reduced. In rural Ghana, buildings with partially collapsed walls and roofs are common (Figs. 15, 18 and 24). Entire villages of earth buildings have been washed away by floods in the Tropical Rain Forestland; the destruction of Nsutam village by floods in 1970 is such an example.

Another example of the poor construction techniques found in the rural areas of Ghana is the absence of surface drainage. This has produced a situation whereby water from the cooking areas and bathing enclosures, as well as rain water from the roofs, collect in the alleys separating individual dwelling units. The stagnant water consequently eats at the base of the houses and weakens the structure which eventually collapses.

A variety of walling materials are used in rural housing. Timber and palm fronds for example, which are used to erect the framework for the wattle-and-daub house in the Tropical Rain Forestland, are not treated chemically against termites or rot. The result is that the framework tends to decay with time, and the overall structural stability is inevitably affected (Figs. 20, 21 and 22). These examples all point to one fact, that rural housing in Ghana is characterized by poor construction techniques.

3.2 UNAVAILABILITY OF AFFORDABLE MODERN BUILDING MATERIALS

Modern building materials utilized for house construction in Ghana include reinforced concrete, sandcrete blocks (manufactured from a mixture of cement, sand and water), glazed doors and windows, terrazzo tiles, plastic tiles and corrugated aluminium roofing sheets. Economic difficulties over the past decade however, have produced a situation whereby most of these building materials have become unavailable. A 1973 rural housing survey carried out on a nation-wide basis by the Building and Road Research Institute (B.R.R.I) at Kumasi established that about 92% of the houses were made of swish (4). Most of these swish houses had developed structural problems due to poor materials selection and poor construction techniques. That such a large proportion of rural houses in the country were constructed in swish is explained by the unavailability of affordable modern alternatives.

Virtually all the modern building materials such as cement for sandcrete blocks, steel reinforcement bars, factory-produced bricks and tiles, and corrugated aluminium roofing sheets are produced in the metropolitan areas of Sekondi-Takoradi and Accra-Tema. These cities are both in the coastal belt. Since this is the only urbanized region of the country, modern building materials are not readily available in the rest of Ghana. Furthermore, economic difficulties have produced a situation in Ghana whereby most of the country's factories have been operating at about half their production capacities. This is the case with cement, bricks, steel rods and roofing sheets. The result has been a perennial shortage of these building materials and the comparatively richer urban population in their large numbers, compete with the rural dwellers for the same building materials.

The 1973 National Rural Housing Survey found that the average cost of a typical rural swish house of four bedrooms was between $300 and $360, although it could be as low as $180 as was found at Asuofa (5). These figures contrast sharply with the cost of 'low-cost' houses developed by various research institutions in Ghana. For example, a so-called low-cost house built by the Housing and Planning Research Department (H.P.R.D) of the Faculty of Architecture at the University of Science and Technology, Kumasi cost $1,260 (6). This was in spite of the fact that the H.P.R.D. scheme utilized intermediate or small-scale technology in methods of production such as stabilized earth blocks produced by a "Tek-block" press, and swish walls with bituminous sand rendering (7). Similarly, a prototype house built by the Building and Road Research Institute (B.R.R.I) at a low-cost housing exhibition at North Kaneshie, Accra in 1972 was estimated to cost $4,170 (8). This project purchased bricks from the Ghana Industrial Holding Corporation's (G.I.H.O.C) brick and tile factory at Weija, Accra. Labour costs alone in the B.R.R.I house was $825 which was 20% of the total costs, and sanitary and electrical installation costs totalled $189. Since rural housing does not usually include luxuries such as electrical and sanitary

FIG.15 TROPICAL RAIN FORESTLAND - VIEWS OF TWO RURAL SETTLEMENTS SHOWING PARTIALLY COLLAPSED EARTH WALLS AND CORRUGATED ROOFING SHEETS.

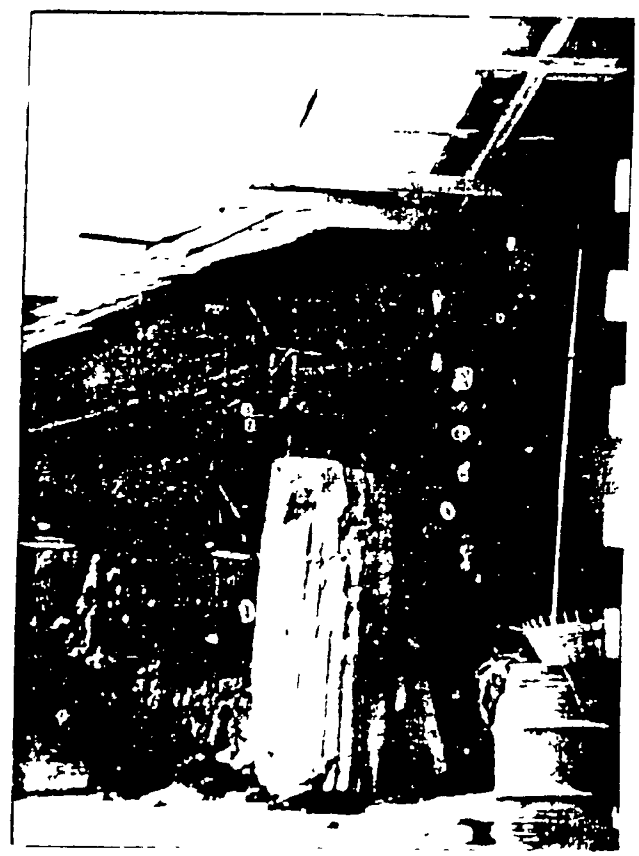


FIG.16 TROPICAL RAIN FORESTLAND - PART OF A WATTLE-AND-DAUB HOUSE. NOTE HOW PARTS OF EARTH INFILLING HAVE FALLEN OUT, EXPOSING TIMBER FRAMEWORK AND ALSO THE FLIMSY TIMBER FRAME FOR THE ROOF STRUCTURE.

installations, eliminating these cost components reduces the total cost of the house from $4,170 to $3,981. But this is still simply too expensive for the rural dwellers. The costs of these houses, obviously then, are beyond what the rural population can afford.

With an annual income of $200 (70% of the rural dwellers cited in Kwamoso and Ayensudo villages earned less than $200 per year), a rural household can only afford a house which costs approximately $250, assuming a 10 year, 10% interest loan. This suggests that the current "low-cost" houses being developed by the research institutions in Ghana are far away from solving rural housing problems. For one thing, in the projects mentioned above both research institutions utilized full-time salaried workers, hence raising the total costs, and ignoring the fact that rural houses are generally owner-built.

Of course, not all houses in rural Ghana are half-collapsed, rickety and run-down swish structures. In the village of Onwi, for example, in the Ashanti Region of the Tropical Forestland prosperous cocoa farmers have discarded their swish houses for new structures of concrete blocks with braced and battened doors, glazed windows, and corrugated aluminium roofing sheets (see Fig. 28). The walls are plastered in sand-cement mix and painted, together with the aluminium roofing sheets, to reduce the intensity of glare in the hot, sunny tropical climate. Such a development suggests that many rural dwellers would opt for more durable and modern building materials like cement, glass and aluminium roofing sheets if they could afford them.

Abrams had written in 1966 that "...substantial economics could be achieved by importing cement clinker in bulk to be mixed and ground in Ghana" (9). By 1980, the situation had changed and a report from the B.R.R.I noted that "Now, the greatest proportion of cement used is processed here from imported clinker and gypsum ground at two factories at Tema and Takoradi" (10). Cement is still imported to balance the requirements. Since 1968, there has been a persistent rise in the cost of clinker and gypsum on the world market. Estimated cement requirement in Ghana per year exceeded 1.5 million tons by 1980 but the existing cement factories had a capacity of only 1.2 million tons. This means a shortfall of 0.3 million tons; the high costs of clinker has not made possible a full utilization of the production capacity.

Against an estimated demand of 113.3 million units of brick and tile in 1979, production per annum was about 6 million units, that is only 5.3% of the demand. This production level is only from the industrialized and mechanized factories in the country. Even though that is supplemented by small-scale manufacturers, the fact is that demand for bricks and tiles far exceed the supply in Ghana. It is probably as a result of this situation that many rural people continue to build their houses in earth. Similarly with an estimated domestic consumption of steel rods and sections at 60,000 tons by 1980, production from the G.I.H.O.C Metal and Steel Works Division only stood at 45,000 tons per year.

There is a large shortfall in the production of modern building materials in Ghana, and demand for these building materials far outstrips the supply. Prices of all commodities in Ghana are fixed by the Prices and Incomes Board (P.I.B). Despite official increases in the prices of cement, steel rods, and aluminium roofing sheets to reflect the prices on the world market, there is a thriving black market for these products. Such factors tend to place the rural dwellers at a disadvantage as far as the availability of affordable modern building materials is concerned. The low levels of income in the rural areas clearly mean that the rural dwellers cannot afford even the official prices for the modern building materials fixed by the P.I.B. Generally, prices of commodities in Ghana tend to increase as one moves away from the capital city of Accra. This situation is compounded by the very expensive costs of transporting products from the production centres in the cities to the rural areas.

The result of all this is that modern building materials are simply not available to the rural dwellers in Ghana. Consequently the practice of using old and familiar construction techniques and building materials continues unabated, and the problems associated with such construction techniques persist. Any attempt to improve rural housing in Ghana must be accompanied either by the broader availability of modern building materials or by improvements to the locally-available building materials and traditional

F[illegible] TROPICAL RAIN F[illegible]R[illegible]ST – [illegible] SHOWING THE [illegible] TIME [illegible] EARTH WALL

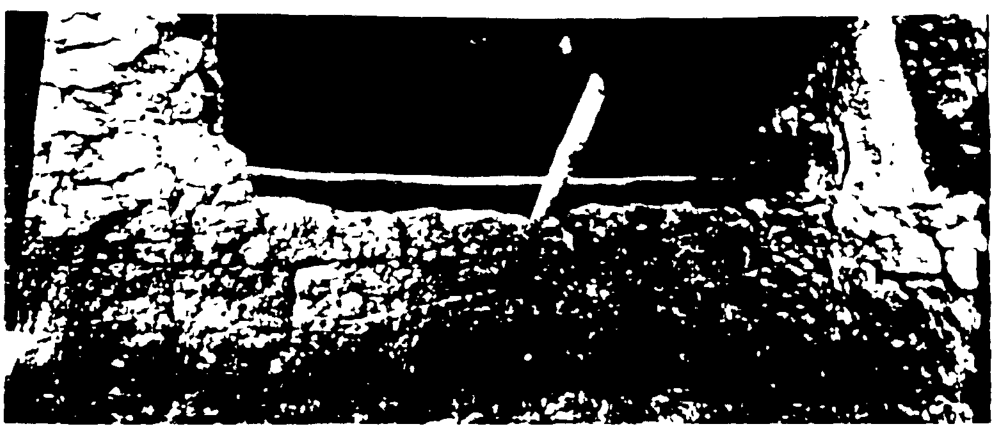


FIG 18 TROPICAL RAIN FORESTLAND – VIEW SHOWING PARTIALLY COLLAPSED EARTH WALL. NOTE THE RAIN ACTION ON THE UNPLASTERED EARTH WALL

FIG. 19 TROPICAL RAIN FORESTLAND - A VARIETY OF BUILDING MATERIALS ARE USED FOR CONSTRUCTION HERE. NOTE THE BAMBOO SLATS ROOF, THE PALM FROND ROOF, THE BAMBOO SLATS WALL AND THE PLASTERED EARTH WALL.

FIG.20 TROPICAL RAIN FORESTLAND - NOTE THE VARIETY OF MATERIALS UTILIZED IN BUILDING CONSTRUCTION, THE RAIN ACTION ON THE UNPLASTERED EARTH WALL, AND THE OPEN-AIR COOKING AREA IN THE MIDDLE OF THE COMPOUND.

TROPICAL RAIN FORESTLAN[illegible] [illegible]
DWELLING UNIT, WITH THE [illegible] [illegible]
RAIN ACTION ON THE WALL

FIG 22 TROPICAL RAIN FORESTLAND - NOTE THE COMBINATION OF BUILDING MATERIALS, WATTLE AND DAUB EARTH WALLS AND CORRUGATED IRON ROOFING SHEETS

FIG. 25 TROPICAL RAIN FORESTLAND - VIEW SHOWING RAISED FOUNDATION (IN RAMMED EARTH) OF DWELLING UNIT IN THE BACKGROUND. NOTE HOW THE FOUNDATION HAS BEEN ERODED BY RAIN ACTION

FIG. 24 TROPICAL RAIN FORESTLAND - VIEW SHOWING COLLAPSED EARTH WALL AND THE USE OF CORRUGATED ROOFING SHEETS TO PATCH WALL.

FIG.25. TROPICAL RAIN FORESTLAND - EROSION OF AN EARTH WALL BY DRIVING RAIN DUE TO NON-ERODABLE WATERPROOF PLASTER.

FIG.26. TROPICAL RAIN FOREST - PEELING OF CEMENT PLASTER FROM AN EARTH WALL.

FIG.27. TROPICAL RAIN FORESTLAND - EROSION OF FOUNDATION OF EARTH BUILDING.

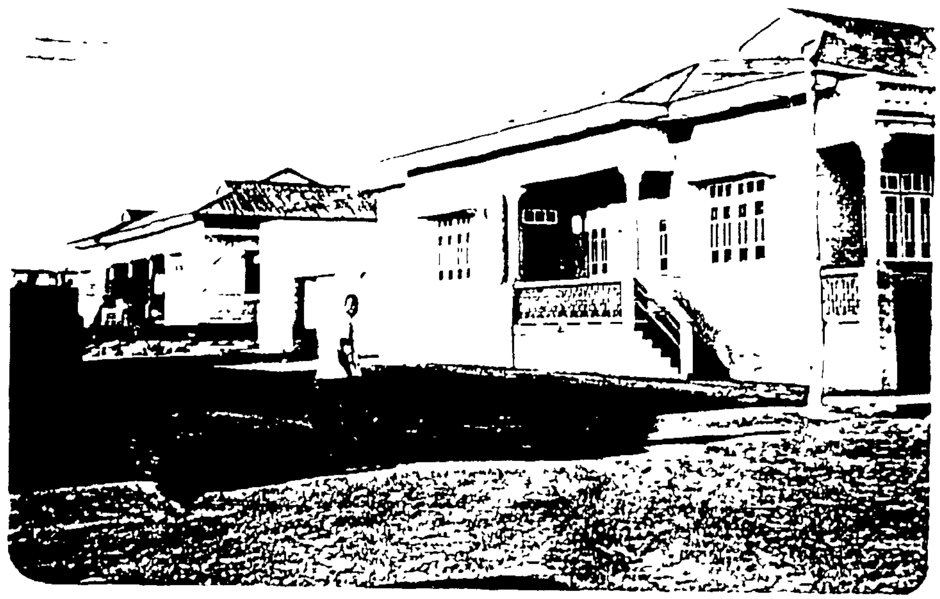


FIG.28 TROPICAL RAIN FORESTLAND - VIEW OF HOUSES OF PROSPEROUS COCOA FARMERS AT THE VILLAGE OF ONWI IN THE ASHANTI REGION. NOTE THE USE OF MODERN BUILDING MATERIALS.

FIG.29 NORTHERN SAVANNA - VIEW OF THE CHIEF'S PALACE IN THE TOWN OF WA. THE HOUSE IS IN MONOLITHIC EARTH CONSTRUCTION AND THIS ILLUSTRATES THE SURVIVAL OF EARTH HOUSES IN THE DRY NORTH.

construction techniques.

3.3 POVERTY IN RURAL GHANA

Compounding the problems of poor construction techniques and the unavailability of affordable modern building materials is the poverty of the rural areas of Ghana, which has aggravated rural housing problems. Productive farmers in Ghana produce over 40% of the total government revenue primarily through the cultivation of cocoa (11). However, although some farmers produce cash crops like cola nuts, shea butter, maize, yam and tobacco most rural farmers still continue to practice subsistence farming. Caldwell in "African Rural-Urban Migration, The Movement to Ghana's Towns", illustrates this latter point in referring to the Northern Savanna (12). He notes how the year is marked into the wet and dry seasons which means that for six months of the rainy season, the people engage in grain farming and animal husbandry and for the other half of year, they engage in gardening and various forms of handicraft. The farm produce is mainly for home consumption though some of it is sent further south to Kumasi and Accra to be sold. Incomes from such farming practices, mainly subsistence farming, are not high.

The estimating of income for the rural sector has been problematic in Ghana. This is because those who earn money are usually averse to declaring their full incomes for fear of being taxed. It is difficult to attempt to put monetary values on agricultural produce which is outside the formal market economy. Attempting to estimate costs for the food items grown by the rural people for consumption is likewise not easy. Data collected by Kodwo Ewusi in "Planning for the Neglected Rural Poor in Ghana", in 1978 confirms the low income levels in rural Ghana (13). Two of the rural settlements he studied, Kwamoso and Ayensudo, are located in the relatively more urbanised Eastern and Central Regions. The data for Kwamoso is presented below in Table 2.

Table 2

Distribution of Household Income - Kwamoso

Annual Income ($)	No. of Households	% of total
0 - 35	4	13.8
36 - 72	3	10.3
73 - 107	3	10.3
108 - 144	5	17.2
145 - 180	4	13.8
181 - 215	2	6.9
216 - 251	1	3.4
252 - 287	1	3.4
288 - 323	1	3.4
324 - 359	2	6.9
Over 360	3	10.3
Total	29	100.00

Source: Kodwo Ewusi:"Planning for the Neglected Rural Poor in Ghana", 1978

In Ghana, wages and salaries (like the prices of commodities), are fixed by the central government through the

P.I.B. The national legal "minimum wage" is the minimum income that a worker must be paid. This is fixed taking into account the subsistence income level in the country, and all employers are supposed to comply with this minimum wage. Generally workers in the private sector tend to earn more than the legal minimum wage. Most often, however, inflation levels have been higher than adjustments to the legal minimum wage, which has meant that many people barely survive on their incomes.

In 1978, the legal minimum wage in the country was $130 but the average household income per annum at Kwamoso was $135. Table 2 illustrates the unequal distribution of incomes with 52% of the households surveyed earning incomes close to the legal minimum annual wage. If it is considered that families tend to be larger in the rural areas in Ghana, then the gravity of the issue of poverty can be better appreciated. Ewusi suggested in 1978 that Ghanaian households earning less than $432 per annum be considered as falling into the poverty class. This suggestion may have been made after taking into consideration the actual subsistence income levels in the country. Using that yardstick, only three of the households surveyed qualified to be above the poverty mark. This means that nearly 90% of the households of Kwamoso could be described as being poor. Even though an income profile may not give a complete picture of poverty profiles, in the absence of better means of assessment, it could be said that from the foregoing analysis poverty afflicts the village of Kwamoso.

Table 3

Distribution of Household Income - Ayensudo

Annual Income ($)	No. of Households	% of total
0 - 71	36	69
72 - 143	8	15
144 - 215	2	4
216 - 287	2	4
288 - 359	2	4
Over 360	2	4
Total	52	100.00

Source: Kodwo Ewusi: "Planning for the Neglected Rural Poor in Ghana", 1978.

At Ayensudo, a much lower proportion of the households surveyed - only 4% - fell into the bracket over $360. Over 95% of the households earned annual incomes below $360 and almost 70% earned less than the national legal minimum wage of $130 at that time. At both Kwamoso and Ayensudo, over 60% of the surveyed households listed farming as their occupation (14). The low income levels in both villages suggest that farming here could be described as being at the subsistence level. The tables and observations made here concerning the two rural settlements tally with the 1973 survey carried out by the B.R.R.I., Kumasi (15). This survey was carried out in the three regions, namely, Ashanti, Brong-Ahafo, and Volta which comparatively are less urbanized than the Central and Eastern Regions mentioned above. About 68% of the people interviewed professed to be farmers. In the same survey, over 60% of the people earned annual incomes below $360. It is important to note that according to these two surveys, the percentage of households earning below $360 per annum increased from 60% in 1973 to over 90% in 1978. The devaluation of the Ghanaian cedi was a factor in the lowering of incomes but in any case, the result was a reduction in the standard of living in the rural areas since most rural dwellers do not produce exportable commodities. The more recent massive devaluation of the currency in 1983 has further reduced incomes and increased poverty in rural Ghana.

Low incomes in the rural sector prohibit expensive construction techniques. Hence maximum use is made of locally available materials and simple construction techniques in order to reduce the cost of the houses. Estimates during the 1973 rural housing survey put the average cost of a typical rural swish house of four bedrooms at between $300 and $360. In the village of Asuofa in the Ashanti Region however, the average estimated cost per house was $180. It should be noted here that many of the rural swish houses in the regions surveyed had corrugated roofing sheets and battened timber doors and windows, unlike the purely traditional houses utilizing local materials throughout, hence the discrepancy in costs.

FOOTNOTES

1. L.K. Afele, _Housing Financing in Rural Ghana,_ B.R.R.I., Kumasi, Ghana. 1975 (p.12)

2. F.A. Abloh et al, _Nsutam Report, a Ressettlement Study,_ H.P.R.D., U.S.T.,Kumasi, 1974 (p.7)

3. A.A. Hammond, "Prolonging the life of Earth Buildings in the Tropics", _Building Research and Practice,_ May/June 1973, London, (pp.154 - 163)

4. L.K. Afele, _op. cit.,_ (p.3)

5. _ibid.,_ (p.10)

6. Kodwo Ewusi, _Planning for the Neglected Rural Poor in-Ghana,_ New Times Corp., Accra, 1978 (p.93)

7. H.P.R.D., _Current Research and Programmes, Vol.1 No.3_ H.P.R.D., U.S.T., Kumasi, 1975-77, (p.4)

8. J.A.K. Nutsugah, _Traditional Dwelling Formation as a Concept for Home Design,_ B.R.R.I., Kumasi, 1977 (p.19)

9. Charles Abrams, _Man's Struggle for Shelter in an Urbanising World,_ M.I.T. Press, Cambridge,Mass.,1966 (p.64)

10. A.A. Hammond, _Development of Building Materials Industries in Ghana,_ B.R.R.I., Kumasi, 1980 (p.4)

11. N.K. Bentsi-Enchill, "Ghana, readjusting the economy", _West Africa,_ 2 May 1983,(p.1053)

12. J.C. Caldwell, <u>African Rural-Urban Migration, The Movement to Ghana's Towns,</u> Australian National Universities Press, Canberra, 1968

13. K. Ewusi, <u>op.cit.,</u> (p.28)

14. <u>ibid.,</u>

15. <u>ibid.,</u> (p.60)

16. L.K. Afele, <u>op.cit.,</u> (p.12)

17. N.K. Bentsi-Enchill, <u>op.cit.,</u>

PART TWO

CHAPTER 4

PREVIOUS ATTEMPTS TO IMPROVE RURAL HOUSING IN GHANA

The continued existence of poor rural housing conditions in Ghana does not mean that efforts have not been made to improve the situation. This chapter will demonstrate that the government of Ghana as well as foreign governments have attempted over the years to improve rural housing. The government of Ghana has been represented by research institutions and the Department of Social Welfare and Community Development which has remained in the forefront of rural development since its inception in 1944 (1). All the nation-wide rural housing programmes have been undertaken by the Department. Research institutions, however, have been engaged in attempts to reduce housing construction costs through the use of locally manufactured materials and small-scale production methods.

4.1 PROJECTS OF THE DEPARTMENT OF SOCIAL WELFARE AND COMMUNITY DEVELOPMENT

Three main rural housing improvement schemes have been undertaken by the Department, these are :

1). The Core-Housing Loan Scheme, or Aided Self-Help.

2). The Roof Loans Scheme, and

3). The Wall Protection Loans Scheme.

The impact of the Wall Protection Loans Scheme could be described as negligible, and it will therefore not be discussed here.

4.1.1 The Core-Housing Loans Scheme

Under the Core-Housing Loans Scheme, credit-worthy individuals were advised by the Department to form cooperative societies. These societies then applied for financial and technical assistance for their members who wished to own houses in the rural areas. Applicants could be natives of the locality residing in the metropolitan centres. The applicants were required to pay a deposit of not less than $172 as a guarantee. This amount was deducted from the total cost of the house, and the difference treated as a loan to be recovered over a period of 10 to 15 years at 10% interest rate. A minimum of 20 applicants with a 20-acre freehold land was required before a project could start.

All transactions were made between the Department and the society, never the individual. During the construction period representatives of the society were required to be on the site regularly to follow the project's development. Beneficiaries were therefore well-informed of rising costs of building materials and the resultant changes in the cost of the housing units on completion of the project.

The first three bedrooms were built under free technical supervision. Families were also assisted with supplies of building materials as well as free communal labour of members of the society. Only modern building materials like sandcrete blocks, steel reinforcement rods, and corrugated aluminium, iron and asbestos sheets, were used for the construction of the houses. This precluded the involvement of the rural population in the production of building materials and also resulted in more costly houses. The construction period of the houses depended on the availability of building materials from the metropolitan centres and transportation costs also increased the cost of the houses.

By 1975, only 12 settlements in the country had benefitted from this scheme with a total expenditure of $119,012 (2). Assuming that each settlement saw the completion of the twenty houses, a total of only 240 houses would have been built in the rural areas. This works out at an average cost of $500 per house. But this is the cost of the first three bedrooms, or the core-house, with an area of about 360 square feet. The deposit of $172 represented 34% of the cost of the house and this is a very high deposit. On the other hand, this works out to be an annual payment of about $80 which can be described as affordable to the rural population. The minimum deposit of $172 and the 20-acre freehold land requirement were major restraints to the successful operation of this scheme. This is because most rural dwellers in Ghana are not "credit-worthy", and could not raise the high initial deposit. It has been noted that the average number of rooms per house in the 1973 National Housing Survey was six. Increasing the number of rooms in the core-house to six under the same conditions would mean another $500 putting the total cost of a house at $1,000. Since only the first three bedrooms were constructed under free technical supervision, the cost of additional rooms in the same materials and construction techniques would have been prohibitive.

This project was relatively expensive for the rural poor and the building methods, and and the modern materials used, were not appropriate. Apart from the prohibitive costs of the building materials and transportation, perennial shortage problems also meant that completion of houses could not be predicted. The rural people were not involved in the production of building materials and the standards set by the Department of Social Welfare and Community Development meant that artisans had to be hired to construct the houses where they could not be met by the owner-builder. That meant increased costs to the beneficiaries of the scheme. Land tenure systems in the rural areas also precluded an easy assembly of plots. These factors contributed to the failure of the scheme which could be described as unrealistic for rural housing improvement.

4.1.2 The Roof Loans Scheme

This has been described as the most intensive programme strictly dedicated to the improvement of rural housing ever to be undertaken by the Department of Social Welfare and Community Development (3). It was instituted in the late 1950s upon the recommendations of the U.N. Technical Assistance Administration and had been highly praised by Abrams (4). The scheme was recommended after the U.N. mission had considered the following factors in Ghana: the keen desire for home ownership, an apparent willingness to save, the ability of many people to build, the availability of some good indigenous building materials, and the absence of a financing mechanism. The mission had noted during its journeys across the country that the roof was the main aspect of the housing problem. "Whether of iron sheeting, aluminium, asbestos, thatch, tile or shingles, the problem of quality, durability or finance persists. If the roof problem can be solved in Ghana, a major part of the housing problem would be eased." (5).

The term "roof loans scheme" was used more for the purpose of identification than for comprehensive description. This is because loans made for the roof included some additional advances for doors and windows, and for finishes. In order to implement the scheme, village housing societies were established. These consisted of a minimum of twenty-five persons who were desirous of obtaining assistance under the scheme. Membership in the society was open to families who intended to build, or have built, a house in accordance with the specifications laid down by the Ministry of Housing. A name was decided upon and registered for the society and its objectives stated i.e. to erect houses according to the specifications of the Ministry of Housing so that the owners could qualify for loans.

The society elected a chairman, vice-chairman and secretary at its first meeting and subsequent meetings were held at least once every two months. In all negotiations one person was nominated to represent the families.

Applications for roof loans were made on a prescribed form which had to be countersigned by the chairman of the society who underwrote the loan on behalf of the society. Societies were approved if recommended by the rural housing assistant in charge of the region in consultation with the Department. Applications were scrutinized at rural housing district offices and warrants and agreement forms issued to rural housing assistants who helped borrowers to complete them. The assistants also advised on the best place for collection of the materials. In requesting a roof loan members were obliged to repay, at stated intervals, the installments due. No further loans were to be made to a society that had a member in arrears. On execution of the agreements the borrowers were given warrants to collect their materials. Changes in the name of supplier, quantity of material approved, their prices and total value had always to receive the prior approval of at least one of the officers authorized to sign warrants. Otherwise the supplier failed to get his bill honoured and the borrower lost his status. When loans of materials were granted, the rural housing assistant again inspected the houses to see that the materials were used only on the approved houses. He also collected repayment quotas and initiated court action against defaulters. The Department of Social Welfare and Community Development advised the Ministry of Housing on the selection of villages for the scheme.

The Department also supplied technical inspectors whose duties included: inspecting all houses to be constructed or under construction by application, advising and assisting in preparing suitable house plans and site layouts for small estates, instructing on methods of construction, preparing estimates of materials and cost of materials necessary for the construction of a suitable roof, and recommending or refusing the issue of a roof loan to an applicant. In assessing the loan-worthiness of a house, or in supplying plans and/or assistance in designing one, the instructors followed the specifications and building by-laws of the local councils in the area. These were modified as were necessary to suit the circumstances and type of house under consideration. The technical instructors received training in their duties, including a course in construction and the important general requirements under the roof loans scheme at a course organized by the Department (6).

The roof frame consisted of 2 in. x 4 in. timber members supported by 6 in. x 6 in. reinforced concrete pillars. Corrugated metal, aluminium or asbestos roofing sheets, depending on their availability, were then nailed to the timber frame to complete the roof (see Fig. 30). The roof was constructed only in modern building materials which were delivered to the site from the cities. Spaces in the houses were defined by solid 18 in. x 9 in. x 6 in. solid sandcrete block walls. This illustrates extreme overdesign, and unnecessarily raised the overall cost of the house. Abrams noted that for a two-room cottage of about 260 square feet in plinth area, the roof cost was estimated in 1954 at about $196, doors and windows at about $22 and lime wash at about

\$6, a total of \$224 (7). This appears to be expensive by 1954 standards and probably contributed to the eventual collapse of the scheme as many beneficiaries could not repay the loans. But Abrams also noted that the total roof cost was about one-fourth to one-third of the value of a completed building, which meant that a completed house cost over \$600. That again could be said to be very costly for the rural dweller in Ghana. The loans carried a one year moratorium and 10% simple interest; Table 4 provides details of the disbursement of the loans.

Table 4

Roof Loan Scheme - Annual Investment

Year	Units	Amount Involved (\$)	Amount per Unit (\$)
1956	967	512,676.	530.
1957	1,457	605,806.	416.
1958	1,930	859,850.	446.
1959	2,482	942,060.	380.
1960	912	241,710.	265.
1961	1,411	529,998.	376.
1962	1,168	436,172.	373.
1963	1,004	360,782.	359.
1964	623	201,026.	323.
1965	196	47,652.	243.
1966	60	15,414.	257.
1967	172	66,069.	384.
1968	189	44,498.	235.
1969	171	25,153.	147.
1970	-	-	-

1971	792	206,342.	261.
1972	192	16,697.	87.
Total	13,726	5,111,905.	

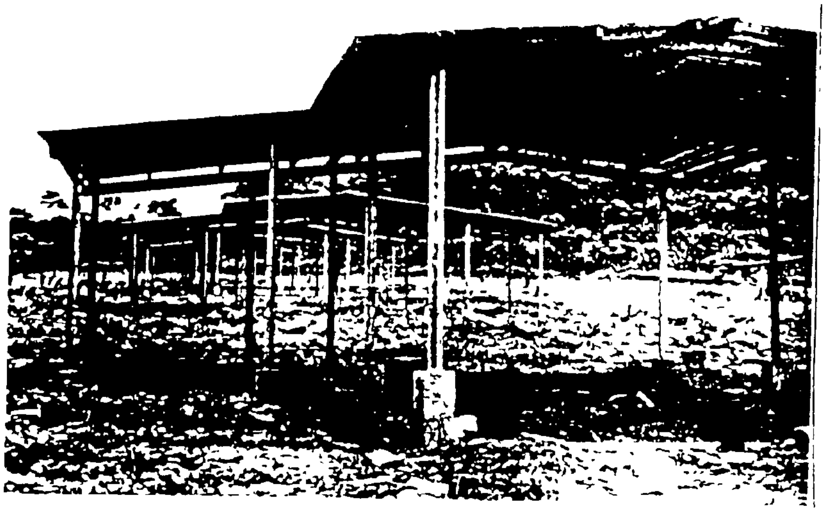
Source: Department of Rural Development, Accra, Ghana 1973

The figures above are in constant dollars and have been adjusted to take care of the exchange rates of the Ghanaian currency, the cedi, as against the U.S. dollar. The discrepancies in the unit cost of the houses could be explained in terms of the location of the villages which enjoyed the scheme. As has been noted the prices of commodities are centrally controlled by the Prices and Incomes Board (P.I.B.), and prices generally tend to increase as one moves away from the capital of Accra.

The performance of the scheme has been closely tied to the political fortunes of the country. For instance, the government which introduced the scheme stayed in office from 1956 to 1966. 1970 saw the election of a new civilian government which had rural development as one of its major policies. This resulted in an upsurge in the number of units in 1971. The military took over the government in January 1972 with its own priorities, hence the drastic reduction from the previous year's level. By 1972 the roof loans scheme had come to a virtual halt and there were many instances of default with one in every three loans in arrears (8). Both the core-housing and roof loans schemes failed because of the apparent patronising role various governments assumed, mixing politics with economics.

Political patronage and economics had been indiscriminately mixed and even when the revolving fund aspect of the scheme was not functioning, governments continued to sustain the programme. Many beneficiaries of the loans schemes perceived the government as a 'Santa Claus' and saw the loans as political payments. Defaulters were consequently numerous. While none of the governments allowed rural dwellers who benefitted from the schemes to not pay back the loans, inconsistent policies and inefficient collection methods implied that no action would be taken against defaulters. According to Afele, the roof loans scheme came to a virtual halt in 1972 because of financial constraints but rapid changes of government with different priorities also thwarted the efforts of the Department of Social Welfare and Community Development.

The roof loans scheme could be further criticized for not making any attempt to produce building materials locally in the rural areas. To quote Abrams, "Since the purchase or production of prefabricated roofing materials would be made in bulk by a public agency, it might be possible, the mission thought, to programme total national requirements and spur wholesale purchases of the roofing materials, windows and doors. Sizes and specifications could be standardized and arrangements made with <u>foreign firms</u> for manufacturing roofing material of prescribed size and quality. All or most of a foreign factory's output could be contracted for at an attractive price" (9). This policy appears to have been followed to the letter and all the



FRAMEWORK IN REINFORCED CONCRETE COLUMNS AND CORRUGATED ALUMINIUM ROOFING SHEETS.

FILLING IN SPACES WITH SOLID SANDCRETE BLOCKS. ENORMOUS OVER-DESIGN HERE.

A COMPLETED CORE-HOUSE.

FIG.30 HOUSING DEVELOPMENT UNDER THE ROOF LOANS SCHEME. NOTE USE OF ONLY MODERN BUILDING MATERIALS building materials like cement, steel reinforcement rods, and corrugated roofing sheets were imported into Ghana before local factories were built in the early 1960s. Financial assistance from the central government in Ghana, in the form of direct cash payments and building materials, has not produced a widespread amelioration in the housing conditions of rural dwellers.

The attempts to improve rural housing which have been discussed here were unsuccessful. A few very expensive and durable houses in modern building materials scattered across rural Ghana did not mean improved rural housing. These attempts had not involved the rural dwellers who had to await the arrival of building materials from the cities before doing anything. If the rural inhabitants had been trained to produce more durable local building materials such as sun-dried earth blocks, burnt bricks and roofing tiles, and to adopt better construction techniques, the schemes probably could have made a more lasting impact. It is in this light that the Biriwa Project comes up for discussion (10).

4.2 THE BIRIWA PROJECT

This project was started as a joint venture between the Ghanaian and West German governments. Initially the project was intended as a way of solving the unemployment problem of the returning Fanti fishermen of the village of Biriwa in the Coastal Savanna. These fishermen had been displaced after the completion of the Tema harbour.

In 1965, fishing equipment worth $43,390 was loaned to over 50 fishermen. Payments were made in installments and spread over a period of 10 years. A group of German volunteers arrived at Biriwa to erect a repair workshop for the outboard motors supplied. In addition a carpentry workshop was established. The Biriwa Project consisted of the following divisions: outboard motor repair workshop, carpentry workshop, fish smoking, community development and commercial transport to cart fish to the hinterland.

The emphasis in this thesis will be on the carpentry workshop and community development aspects of the project. When in 1967, the project started its carpentry workshop, the idea was to train young middle school leavers in the artisan trade in order to reduce unemployment among the youth. It was also intended to reduce the drift of young people from the rural to the urban centres. The carpentry workshop turned out to be a commercial success in the sense not only of the profits made but more especially because most of the rural youth showed a keen interest in this type of training. A rural arts and crafts vocational training centre was therefore established. The training programme covered the following categories of young people:

1). The unschooled, (i.e. those who had never been to school),

2). the drop-outs, (i.e. those who had been to school but had not completed the primary school course), and

3). the school leavers, (i.e. those who had finished a fixed level of schooling but who then encountered difficulties in finding appropriate employment).

The training content in the building construction programme included courses in the production of landcrete and sandcrete blocks, in the preparation of layouts, in laying foundations, in building construction (including roof construction), and in the construction of doors and windows (i.e. carpentry).

The rationale behind the programme was that the graduates should go back to their villages armed with the basic information and skills required to participate in community development. Refresher courses were held once a year, and taken in its totality, the Biriwa Project centred on community development "from below".

Evidence of the success of the project is seen in the more durable houses which have been constructed by graduates of the scheme in the nearby towns and villages such as Anomabu, Saltpond, and Kormantsi, to name a few and the following reasons describe its success:

1). Improved construction techniques were imparted to rural dwellers in their own locality.

2). The scale, techniques, and materials used during the training,--such as small-scale production of soil-cement and concrete blocks, and the construction of more durable houses, --were relevant to the needs of the rural people.

3). The West German agency responsible for the operation of the project did not insist that building materials be imported from West Germany.

In order to be meaningful, any effort to improve rural housing should have the following characteristics: it should allow the complete participation of the rural people, it should include vocational training in the rural areas on a mass scale, it should insist on the production of locally-available building materials by the rural dwellers, and it should utilize methods simple enough to be understood and carried out by the people.

FOOTNOTES

1. Kodwo Ewusi, *Planning for the Neglected Rural Poor in Ghana,* New Times Corporation, Accra, 1978 (p.79)
2. L.K. Afele, *Housing Financing in Rural Ghana,* B.R.R.I., Kumasi, 1975 (pp.24-25)
3. U.N. Technical Assistance Administration, *Housing in Ghana* Report presented to the Ghana Government by the U.N., New York, 1957, (p.76)
4. Charles Abrams, *Man's Struggle for Shelter in an Urbanizing World,* M.I.T. Press, Cambridge, Mass., 1966, (pp.182-191)
5. *ibid.,*
6. U.N. Economic Commission for Africa, "Some problems of rural housing in Africa," *Working Paper No.22,* (pp.28-30)
7. Charles Abrams, *op.cit.,* (p.187)
8. L.K. Afele, *op.cit.,* (p.23)

PART THREE

CHAPTER 5

IMPROVEMENT OF TRADITIONAL CONSTRUCTION TECHNIQUES

To improve the traditional construction techniques in rural Ghana, it is necessary to deal with the factors which contribute to the problem of rural housing. These factors have been identified as poor construction techniques, the unavailability of affordable modern building materials, and poverty. How can these problems be solved ?

5.1 INTRODUCTION OF IMPROVED CONSTRUCTION TECHNIQUES

Various attempts to improve rural housing in Ghana have been noted. These have included outright construction of new houses in modern/conventional building materials and by full-time salaried employees of government agencies. There has also been the involvement of research institutions such as the B.R.R.I., and the H.P.R.D. of the University of Science and Technology at Kumasi. These research institutions have tried to adopt what are described as "appropriate technology" methods to improve rural housing.

It has been noted that the main causes of deterioration of swish buildings in Ghana are shrinkage cracks, erosion and underscouring. Whilst most of these defects are due directly or indirectly to rain action in the Tropical Rain Forestland, the effects of sand-laden wind action in the Savanna areas are equally devastating. On the other hand, earth buildings have been known to have existed for centuries in dry climates of the world like Kano in Northern Nigeria, Sian Fu in China, and at Larabanga in Northern Ghana (1). The performance of earth buildings in northern Ghana has been satisfactory where there has been little or no rain (Fig.29); more swish houses collapse in the Tropical Rain Forestland than in the Northern Savanna. The durability of swish houses largely depends on the ability of the walls and foundations to resist water and wind penetration. Water being the main cause of rapid deterioration, the problem then is how to make these buildings adequately water resistant.

5.1.1 Improvements to Swish Houses

In the past, no attempts were made to make swish houses walls waterproof, or to make the houses solid. Swish walls were simply erected on raised earth floor-slabs of about six inches thickness. This resulted in the underscouring of houses as well as susceptibility to settlement cracks and erosion.

As it is the base of the outer walls of the swish houses that deteriorates far more quickly than the rest, it is necessary to provide adequate foundations for the houses. With quarries in all the regions in Ghana, and difficulties with the availability of modern building materials, rubble foundations are recommended for the construction of new houses. This type of foundation works well. Instead of building a footing and foundation wall, the rubble foundation can be constructed in one piece which tapers up so that it is the width of the swish wall at the top (2). (Fig. 31).

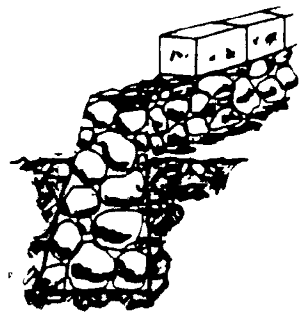


FIG.31 TAPERING RUBBLE FOUNDATION TO SUPPORT EARTH BLOCKS OR BRICKS

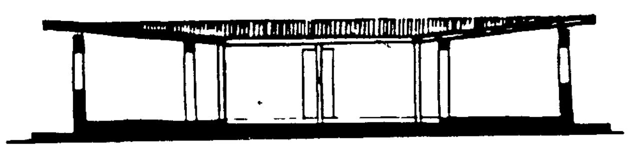
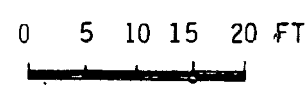


FIG.32 CROSS-SECTION THROUGH IMPROVED EARTH BUILDING BY THE H.P.R.D. WITH BITUMINOUS SAND PLASTERING AND RAISED PLATFORM AROUND IT.



Where there are no stones, broken brick could be used. The largest stones should be placed at the bottom of the foundation and the top covered with a thin layer of mortar to provide a smooth, level surface for the first layer of the wall. A good strong mortar of the following mix would be suitable : 4 parts of cement, 1 part of lime, 12 parts of clean sand and sufficient water to make a workable mix (3). Since the excavation for the foundation wall and footing is wider than the foundation wall, it must be backfilled. The backfill material should be the native earth removed from the excavation. This should be placed back into the excavation and compacted.

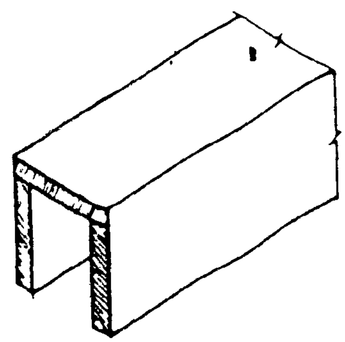
For a typical Ashanti courtyard house of 1220 square feet (excluding the yard) as illustrated in Fig. 11, a 2 ft. tapering one-piece foundation in broken bricks at a retail price of \$0.30 per square foot (from \$0.13 quoted by the B.R.R.I. in 1971 and assuming an annual inflation rate of 10%) would cost \$300 (this does not include mortar cost). If the assumption is made that the broken bricks would be sold at half the retail price, the foundation cost becomes \$150. But if the bricks are produced by the owner-builder with the same production costs as the B.R.R.I. experiments, (to be discussed on page 102), the cost of the foundation is \$72. The cost of imported lime in 1974 was \$103 per ton which meant \$0.05 per pound but that of locally-produced lime was \$39 per ton or \$0.02 per pound at the same time. At 1984 rates, (assuming a 10% annual inflation rate), locally-made lime costs \$78 per ton. Assuming that two tons of lime are used for the foundation, the total foundation cost is under $400. This can be compared favourably to the foundation cost of the B.R.R.I. "low cost" brick house (built in Accra in 1971) at $875, which was 14.7% of the cost of the house. This foundation would cost $2,000 today.

However, if stone is used for the foundation, lower costs would be achieved. Throughout rural Ghana, there are several rock deposits which are 'owned' by the traditional authorities and have been quarried for various purposes such as culvert, road and communal facilities construction in many localities. If stones are collected by the owner-builder, the only costs incurred would be for the purchase of lime for the mortar. Hiring labourers to cart stones from quarries to building sites would, however, mean increased costs but if the system of free communal labour is adopted so that a common pool supplies stones to all building sites, (as is the practice with rural communal construction), costs incurred would be for the purchase of lime. Either way, stone foundations would cost less than 50% of brick ones, that is under $200. The use of stones and lime mortar for one-piece tapering foundations is economical.

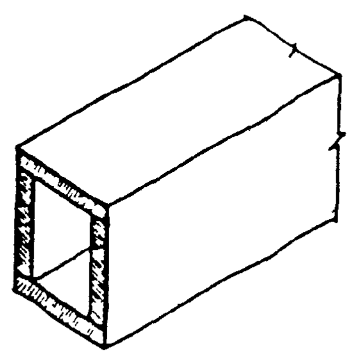
A method has been used to improve wattle-and-daub houses in the Kwango area of Zaire (4). This technique is intended to make existing earth houses semi-permanent in areas where the high price of concrete, poor transportation facilities and ignorance make more expensive methods impractical. The base of the outer walls of the house is reinforced by digging a shallow foundation between 12 in. and 18 in. deep and about

FIG 33 TYPICAL WATTLE-AND-DAUB HOUSE BEFORE IMPROVEMENT IN KWANGO, ZAIRE

FIG.34 AN IMPROVED HOUSE IN KWANGO, ZAIRE.



LINTEL FOR EARTH HOUSES FROM THREE TIMBER PIECES



LINTEL FOR EARTH HOUSES FROM FOUR TIMBER PIECES.

FIG.35 TIMBER LINTELS FOR EARTH HOUSES.

18 in. wide around the already constructed house and up against the walls.

Digging must not be carried out on more than two sides of the house at any one time as the walls are liable to collapse. The trench is filled with stones and ordinary clay mortar. On these foundations a low supporting wall is built, 18 - 36 in. high, depending on the amount of stones available, using the same mortar as for the foundations. The mortar is then scraped close to the main walls and a joining layer of cement added. The top of the low wall is protected by a sloping layer of cement to allow rain water to drain off. Finally a coat of sand-cement plaster is put on the upper part of the main wall, and finished off. This work does not require a highly qualified mason, and once the method is well known, any mason can do it (see Figs. 33 and 34). Concrete platforms, or aprons, around swish houses have been effective preventive measures against erosion also, as has been illustrated in research housing schemes by the H.P.R.D. of the Faculty of Architecture at the University of Science and Technology, Kumasi in Ghana (Fig. 32).

Swish houses need large overhangs to direct rain water away from the walls. Especially in the Tropical Rain Forestland, rain water gutters are necessary, and verandahs or aprons around the houses should have floors sloped away from the walls so that no standing water collects by them.

One of the weakest spots in rural swish houses is above the doors and windows. Note has been taken of the presence of sagging 2 in. thick timber members as lintels in swish houses. A lintel however, has to be strong enough to support construction loads as well as the weight of the wall above. A large timber or a reinforced concrete beam makes a good lintel but for reasons noted, timber lintels would be strongly suggested here. The lintel should be as thick as the wall so that it can support the load above. It should also project out on either side of the door or window for a distance at least equal to the thickness of the wall so it will have plenty of surface to rest on. For walls 6 in. and 9 in. thick, and to span openings of about 3 ft., three timber pieces 4 ft. by 2 in. by 6 in. could be assembled as shown (Fig. 35) as a lintel. For openings over 3 ft., in walls 12 in. and 15 in. thick, four of such timber pieces could be assembled to form a lintel.

Rendering provides protection against damage to swish walls and prevents water penetration. The absence of effective rendering to swish walls has caused rapid deterioration, and has resulted in the collapse of buildings. Some waterproof rendering has been attempted but the cheap ones are ineffective. Cow dung, boiled banana or plantain stem mixed with lateritic soils as well as mud plaster are all used on swish house construction in various parts of Ghana. Whilst these materials work in the dry northern climate, they have failed in the Tropical Rain Forestland. They are easily washed away by the heavy rains. There is a need to find better construction techniques as well as more durable materials to construct waterproofed swish walls. Three such techniques are rammed earth, sun-dried earth, and brick construction to be finished off with lime plaster.

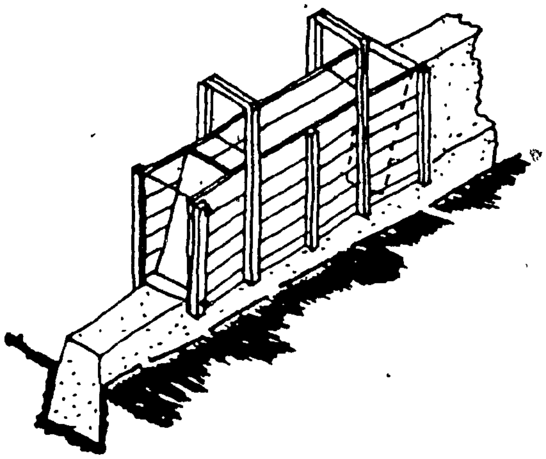
5.1.2. Rammed Earth Construction

In this method, continuous walls are built by ramming moist soil into position between heavy wooden forms (6). The best natural soil for rammed earth construction is either sandy clay or clayey sand. After finding the right type of soil the most important thing to do is to build the form or mould to ram the earth in.

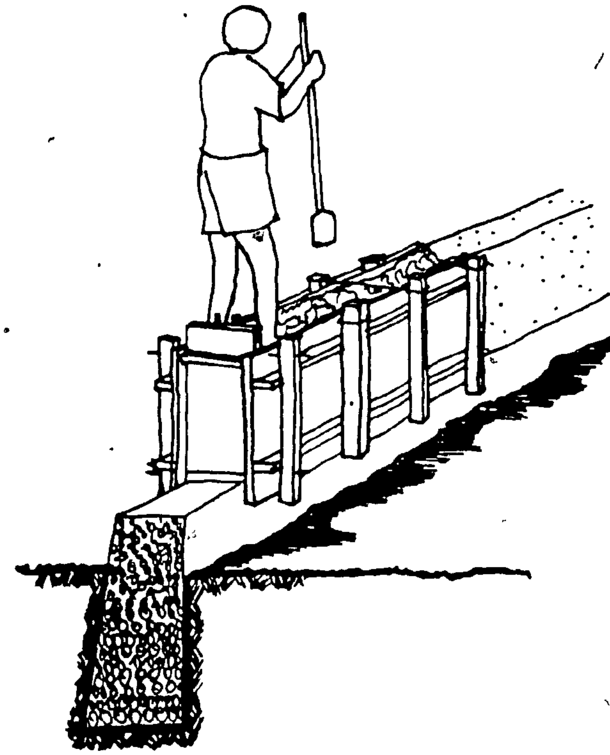
5.1.2.1. How to Build Forms

The forms for rammed earth construction are like those used for poured concrete. They are simply rectangular boxes without top and bottoms into which earth is pounded. The forms must be strong because they have to stand a lot of abuse before the walls are finished. Since they will be moved often, they must not be too heavy for a couple of men to lift. A simple form can be made like the one shown in Fig. 36. Two-inch thick lumber (2 in. x 6 in., 2 in. x 8 in. or 2 in. x 10 in.) nailed to 2 in. x 4 in. braces or studs spaced 24 - 36 in. apart. Bolts could hold them together. The bolts should be long enough to extend through the forms and studs with a threaded position protruding a couple of inches. After the forms are removed, the bolts are driven out of the wall and the holes filled with tightly rammed soil mix. Special forms from the same type of wood are needed for corner sections.

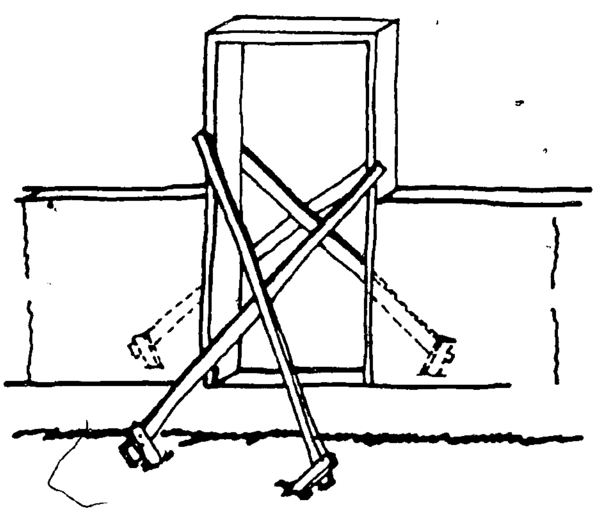
In building a rammed earth wall, the bottoms of the



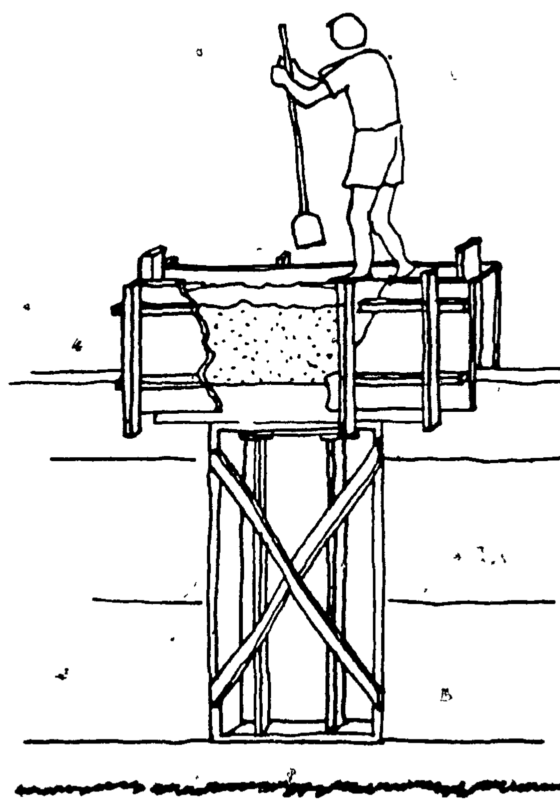
FORMWORK IN PLACE FOR EARTH.



RAMMING THE EARTH IN THE FORMWORK.



FIXING DOOR BEFORE COMPLETION OF WALL.



CONTINUING WALL AFTER DOOR IS IN PLACE.

FIG.36 RAMMED EARTH CONSTRUCTION.

panels are clamped tightly over the foundation wall or a section of finished wall. To space the top of the forms, 2 in. x 2 in. wood spacers cut to exactly the same width as the wall are used.

To keep the earth from coming out of the forms at the ends, end gates are used; they should be as thick as the rest of the forms. End gates also serve as spacer blocks at the end of the forms and should be as wide as the wall. In most cases, end gates are used at the end of the forms but they should be made to fit any place inside the forms in case short wall sections have to be rammed. They should also be spaced so that they will be at least 8 in. from the nearest bolt. If enough room is not left, it will be difficult to ram the soil correctly. A bevelled piece of wood should be nailed on the end gate so that it faces the inside wall. When the earth is rammed in the forms, the bevelled piece forms a groove in the of the wall. When the next section of the wall is rammed, the groove is filled with earth to form a solid joint that bonds the sections together.

Forms should not be made deeper than 24 in. or 30 in. If they are deeper, ramming the earth correctly at the bottom of the forms may be difficult. Only seasoned lumber should be used for the forms since green lumber will warp. Forms should be oiled with a lightweight oil to stop warping and keep the soil from sticking to the lumber. When forms are not being used, they should be stacked flat in a protected and well-drained area.

A good rammed earth wall should be tamped from top to bottom. Hand tampers are recommended. The weight of the tamper is very important. The heavier it is, the faster the earth can be rammed. A tamper with a 3 in. flat face and weighing 18 pounds is recommended.

5.1.2.2. Construction Procedure

The forms are placed over the foundation wall and drawn up tight against it with the bottom row of bolts. The end gates and spacer blocks are inserted and the top row of bolts is tightened. Ramming is then started (see Fig. 36). When a section is completed, the forms are moved, fastened tightly at their new location, and ramming continues. A complete section of the house is rammed before starting the next layer. Joints between layers should be staggered like those in pressed blocks so they do not form a single weak line in the wall (see Fig. 36).

The first sections of the wall to be rammed should be the corners of the house. Particular care should be taken to make sure that corner forms are perfectly vertical. This is most important and should be checked often, because a rammed earth wall that is built leaning can never be straightened. String lines stretched between the corners should be used to line up wall forms and assure straight walls. Newly constructed wall sections should be protected until they gain strength; exposed walls should be covered with mats, and heavy cloth both at night and when rain threatens. Such protection should cover the top of the wall, since erosion starts there first. Walls stabilized with cement, lime or other cementing-type stabilizers should be protected and kept moist during the entire curing period. Sacks or mats, moistened several times daily are good for this. For soils with cement-type stabilizers in them, a waiting period of 3 or 4 days, is recommended before the next section is rammed on top of an earlier lift. Generally, ramming on top of any wall section can be done as long as it does not crumble or crack. Before ramming a new section, the top of the lower completed section about 1/2 in. deep should be scratched with a pointed wood or steel stake. If it is dry, the top should be moistened slightly to improve the bond between sections.

Scaffolding or other supports may be necessary when the wall is high and the forms have to be moved around. The moisture content of the mix should be checked often and too wet or too dry mixes should be remixed. Ramming should also be checked often. This can be done by shoving a sturdy knife blade into various spots in the rammed layer. Soft spots found in this manner should be rammed some more. The important places to check are directly against the forms, in corners, and around levelled strips on end gates.

Openings for doors and windows can be done in two ways. One way is to set the door and window frames first and ram the earth around them. If this is done, the frames should be solidly braced as shown in Fig. 36 otherwise they will be forced out of place by the high pressures produced by ramming. Door and window frames should be braced across the diagonals so that the openings remain square. Frames should be as wide as the walls and should have ties sticking into the walls to hold them firmly in place.

The other way is to ram the earth first leaving an opening in the wall for the frames. When this method is used, the bevelled strip is removed from the end gate. The end gate is then accurately positioned at the spot where the opening is to occur. Wooden nailer blocks are placed in the wall so that the door and window frames can be securely attached to them. The blocks are placed on top of a tamped layer and adjacent to the end gate. The next layer is tightly rammed around the block to hold it securely in position.

The pressures from ramming the earth on top of a lintel may be great enough to cause it to break or permanently sag. To keep this from happening sturdy braces must be put beneath the lintel during ramming as shown in Fig. 36, or the house could be built so that there is no earth wall over the door and window openings.

Materials needed for rammed earth construction in rural Ghana include earth, lime stabilizer, labour, and timber for the formwork. Of these only timber and lime stabilizer need to be purchased. Timber is abundant in the Tropical Rain Forestland and lumber is sold by both large-, and small-scale mills throughout the country. In 1974, the cost of plywood per cubic foot was $7 and that of lumber was $0.40 per cubic foot (7). At 1984 prices, assuming 10% annual inflation rate, these become $16.50 and $0.90 respectively. Lime is favoured as the stabilizer for this construction process.

(The use of lime as a stabilizer will be examined in the next section). Assuming a 10% annual inflation rate and using the 1974 cost of lime at $39.00 per ton or $0.02 per pound, the 1984 cost is $92.00 per ton or $0.05 per pound. Rammed earth construction is economical in rural Ghana (detailed construction costs would be discussed on page 128).

5.1.3. SOIL-CEMENT CONSTRUCTION

Construction of houses in soil-cement blocks has been carried out in both demonstration and urban housing projects by the H.P.R.D. in Ghana. In a cooperative housing project at Tema, carried out with its assistance, the following results were achieved (8). Using the "Tek-block press" designed by the Department and built by a local manufacturer, the press costing $30 produced 200 to 400 soil-cement blocks a day. The block had the following dimensions 11 1/2 in. x 8 1/2 in. x 5 1/2 in. The actual number of blocks produced depended on the skill of the operating crew. The press produced about 60 soil-cement blocks from one bag of cement. This can be compared to 20 conventional concrete blocks (18 in. x 9 in. x 6 in.) produced from the same bag of cement. This worked out to a material cost of $0.10 per square foot of wall surface for a soil cement block compared to $0.20 per square foot for a concrete block.

The use of soil-cement blocks for rural house construction resulted in significant savings in Tanzania (9). The country faces a perennial shortage of cement and transport costs feature prominently in final building costs.

The use of soil-cement blocks reduced transportation costs alone from over 40% to under 5%. According to the article, both for self-help and contractor-built houses, soil-cement was the cheapest material per year of occupancy. The table below compares costs of walls constructed in different materials and by different production methods.

Table 5

Comparison of costs per square foot of finished walls in different building materials (in U.S. $) in Tanzania.

Building Material	Material Cost	Labour Cost	Total Cost
Soil-cement (mix 1:16)	0.07	0.12	0.18
Plastered mud and pole	0.09	0.09	0.18
Sand-cement blocks (1:11)	0.16	0.09	0.25
Factory-made concrete block	0.26	0.05	0.31
Factory-made burnt clay brick	0.26	0.09	0.35

Source: "Soil-cement for low-cost housing", by J.P. Moriarty et al., in Building Research and Practice, May/June 1975.

Soil-cement blocks combine many of the advantages of both concrete and sun-dried earth blocks. Since the soil is used as aggregate, no money is needed for buying sand and gravel, or transporting them. Soil-cement blocks could be therefore utilized for rural housing improvement in Ghana. The perennial shortage of cement in Ghana has been noted; lime could be used as a stabilizer. Clayey soils can be made into a better building material by the addition of a stabilizer. A stabilizer cements the particles of soil together so that the block or wall is stronger, "waterproofs" the soil so that it does not absorb water, and keeps the soil from shrinking and swelling (10). In a very dry climate such as the Northern Savanna, there is less need for a stabilizer because of the scanty rainfall. (Soil-cement house cost discussion in Ghana is on page 129).

5.1.4. Vocational Training Facilities

One means of addressing the problem of poor construction techniques is the establishment of vocational training facilities in rural Ghana. The words "school" and "institution" are intentionally avoided here because these have largely been connected with facilities with permanent buildings for classrooms, offices and workshops ; in other words, schools and institutions have become synonymous with formal education in Ghana. Instead, the idea is to carry the actual training process to the people in the rural areas.

An approach similar to that utilized in the Biriwa Project is to be followed. That project covered virtually all the middle school leavers, drop-outs, and also the unschooled. As Farrow notes, better education (in the context of schools and institutions as used in Ghana) also tends to increase migration potential since many migrants tend to be younger, better educated individuals or families not yet tied to rural life (11). This tendency has been given practical demonstration in recent years. Most of the recently graduated professionals such as architects, urban planners and engineers from the country's universities and polytechnics have left for Nigeria soon after graduation.

Literates tend to migrate more from Ghana than illiterates. Since the proposed vocational training is to be carried out in the rural areas for not only the youth but the old as well, and also for both the literate and illiterate, the possibility of all the beneficiaries migrating is remote. Participants at these training programmes would acquire new construction skills in their own surroundings as the instructors illustrate these to them.

Vocational training in the production of landcrete and sandcrete blocks, in the preparation of layouts, in laying foundations, in carpentry, and also in rammed earth construction, lime, and burnt bricks production for small-scale use would give the rural dwellers the chance to make choices. If some of them became more prosperous and wanted to build their houses in concrete blocks for example, then artisans would be available. Such vocational training throughout rural Ghana would result in a corps of locally-available artisans to help improve the rural housing situation. This type of training would also teach the rural dwellers improved construction techniques in locally-available materials.

It has been noted that virtually all building in the rural areas in Ghana is accomplished through self-help and that almost everybody is a builder of some sort. The establishment of vocational training facilities would result in a larger number of builders with improved skills in building construction. The result would be better built houses in the rural areas. Such programmes could make a more lasting impact on the rural communities than demonstration houses which are always constructed by salaried employees who only stay in the rural areas during the construction period.

It has been suggested that full-scale direct government financial involvement in rural housing improvement is not advisable. This suggestion only refers to direct payments like cash loans or grants in the form of building marerials which are shipped from the cities, but which could just as easily be produced locally in the rural areas. Any attempt to ship prefabricated wall units, steel rods, glass windows and corrugated aluminium roofing sheets from factories in Accra to the rural areas for rural housing improvement will likewise do nothing to encourage local enterprises. Previous attempts at rural housing improvement, such as both the roof loans and wall protection loans schemes hardly made any impact on rural housing.

Rural housing improvement has been stressed by various governments in Ghana as a major priority. Organizing vocational training as a government-funded programme would appear to be the right approach. Instead of providing technical assistance in the form of imported building materials, which the fragile economy of Ghana cannot support, instructors from the technical institutions and universities could conduct vocational training. These institutions are all funded by the central government and a scheme could be worked out to involve them in rural housing improvement programmes.

5.2. ESTABLISHMENT OF COTTAGE INDUSTRIES TO PRODUCE BUILDING MATERIALS

A lack of affordable building materials has been identified as one of the main factors which have contributed to rural housing problems in Ghana. Any system which will enable affordable building materials to be available to rural dwellers would ameliorate the situation. Consequently, it becomes necessary to establish rural or cottage industries to produce building materials within the rural areas themselves.

Abrams noted in 1966 that local materials remained undeveloped in Ghana while foreign materials were imported, on the assumption that they were automatically superior (12). He described the situation in the Northern Savanna, where adobe and thatch had survived, but where roofs of imported materials were beginning to appear. At the time, 13% of Ghana's total imports were building materials, at least some of which could have been locally made. For example, prefabricated Shokbeton houses with heavy and brittle slabs, ill-adapted to the climatic conditions of the country, and unnecessarily highly expensive were being imported into Ghana in the 1950s (13). But houses could have been constructed in bricks, soil-cement blocks, sun-dried earth blocks and clay roof tiles.

Hammond in "Development of building materials industries in Ghana", mentions that Ghana has identified some areas for development in the building materials industries where demand is very high (14). These areas include clay products (bricks, tiles and drainage pipes), cementitious materials (limes and pozzolanas), timber products, stabilized soil blocks, and stone products. In the past, the development of building materials industries had only been considered in terms of highly industrialized and mechanized factories. This is exemplified by the brick and tile factories owned by the Ghana Industrial Holding Corporation (GIHOC), the Bank of Ghana, the National Investment Bank, and the Regional Development Corporations, the cement factories owned by the Ghana Cement Works Company (GHACEM), and the lumber mills owned by the Ghana Timber Marketing Board. These plants are mostly sited in the cities and their products are therefore in high demand by the more prosperous urban population. The rural population hardly feels the impact of such industrial plants. Where vast deposits of raw materials are located in the rural areas, like timber in the Tropical Rain Forestland and pozzolana at Awaso, also in the same area, the huge investment required to process them at industrial plants has meant that these materials have remained unused. The question now is how these materials can be utilized without the importation of sophisticated industrial equipment, and by adopting a scale of production that can be readily understood, and can be made mobile enough to cover a group of villages and towns. Instead of an automated brickyard requiring engineers and skilled men for its operation and maintenance, with a total loss of production if it breaks down, firing clamps which come small enough to be used for a group of two housing units could be used, as has been done in Nigeria (15).

Rural housing improvement in Ghana cannot proceed along the same lines as in the urban centres. A complete transfer of modern and conventional building materials and construction methods to the rural areas may not happen overnight, or even in the immediate future. The approach being discussed here is one which seeks to improve present traditional construction practices by incorporating relevant, modern intermediate construction technology. An approach similar to what Witold Rybczynski refers to in China as "walking on two legs" is to be pursued (16). This approach allows the existence, side by side, of cottage industries at the village level with little machinery, and affordable and relevant small-scale industrialized production methods involving the local people, with larger centralized production centres, where economically and technologically appropriate.

5.2.1. Small-scale brick factories

The establishment in Ghana in 1973 of two brick factories along lines advocated by the International Technology Development Group (I.T.D.G.) based in Great Britain is an example of appropriate technology (17). The two factories were sited at Asokwa in the Tropical Rain Forestland and at Amisano in the Coastal Savanna, and were financed under British Technical Aid and constructed by the B.R.R.I.

At Asokwa, about 40 miles of Kumasi, the brickmaking industry employs 26 people. Imported components were under

10% of the capital costs while the rest were obtained locally. Natural air is used to dry the bricks after they have been shaped, and the kiln burns local firewood. The only imported source of energy consumed is for a small 10 HP diesel engine which drives the clay mixer. Production level was at 206,240 units in 1975. In the event of a mechanical breakdown, the tools and equipment are types familiar to local car mechanics who also service the small maize grinding mills which operate in the village. Similar conditions existed at the plant at Amisano which in 1975 produced 262,540 units. Both plants sold bricks in 1975 at $0.03 per unit of size 2 5/8 in. x 4 1/8 in x 8 5/8 in.

5.2.2. Production of Burnt Clay Bricks in Wood-fired Clamps

In "Manufacture of burnt clay bricks in wood-fired clamps", Bawa describes methods for making good quality burnt clay bricks at low cost (18). This method could be easily adopted by semi-skilled workers near potential sites for housing projects. Three major considerations for site selection for the manufacture of bricks on a small scale are:

1). The site should be as near as possible to the housing project or the area of maximum demand,

2). brick earth of suitable quality should be available in sufficient quantity, and,

3). firewood, at lowest possible cost, should be available.

Along with these considerations, adequate supply of water and

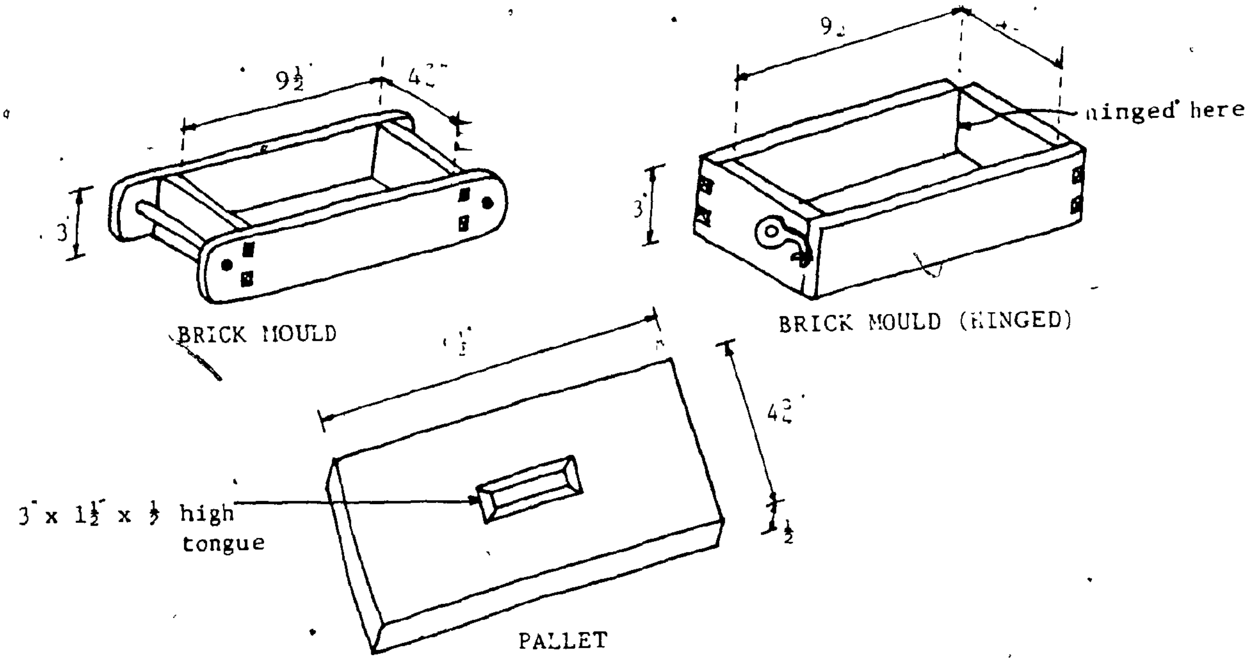


FIG.37 TOOLS FOR SMALL-SCALE BRICK PRODUCTION.

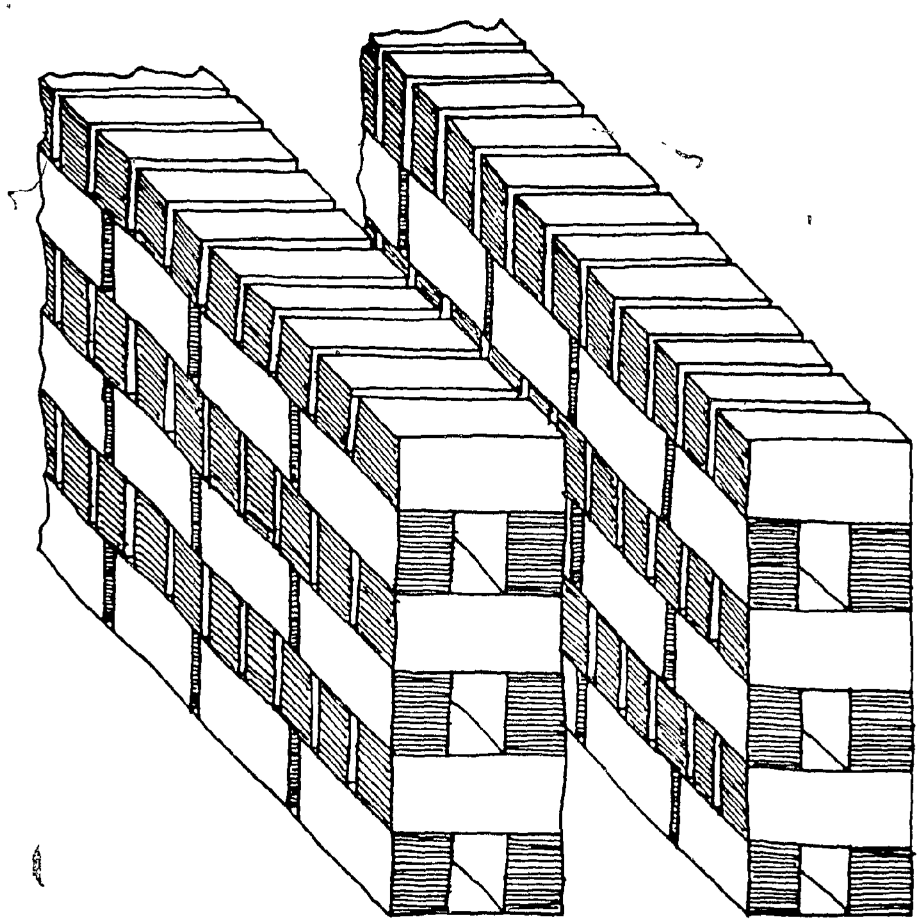


FIG.38 STACKING OF PARTIALLY-DRIED BRICKS.

sand for mixing with clay should also be available. The ground where bricks are to be moulded and dried, as well as the site for erection of the kiln or clamp, should be flat. A simple shed of adequate size and open on its sides must also be provided where the weather is likely to hinder the proper drying and burning of bricks. The soil for making solid bricks by moulding process should neither be very clayey nor very sandy, and should be a good mixture of fine sand, silt and clay (19).

The soil is dug and brought to the site where the bricks are to be moulded. Two or three pits of about 8 ft. by 8 ft. and 6 in. deep can be used in turn to give regular supply of prepared soil for moulding. The soil layer in the pit should be only 4 - 6 in. deep for easy working with the feet; wet soil can be worked directly with bare feet by the workmen but dry soil should be soaked overnight before being trodden. Treading is more efficient if after going over the whole area of the pit twice, the clay is turned over with a spade and retrodden. In the absence of pits, soil may be heaped on a solid platform, soaked overnight with water and trodden the next day. After treading, the plastic clay is removed from the pit and stacked near the moulding bench and properly covered with a damp sack till moulded into bricks.

Moulding is done by hand and simple moulds made out of hardwood can be used. These can be single or multiple - for as many as five bricks at a time. The inside dimensions of the mould should be bigger than the required size, about 11%, to allow for shrinkage of bricks on drying and burning.

Fig. 37 shows tools for small brick production. A single wooden mould for making standard brick of nominal size of 9 in. x 4 1/2 in. x 3 in. can be used. A hinged mould provides for easy removal of bricks. A pallet with an elevated tongue, gives the required size of frog. A frog in the brick helps in its drying and burning as well as better adhesion with mortar, and also makes bricks lighter in weight for easier handling. This further reduces fuel needed for burning.

Before making the bricks, the mould is either wetted with water or sprinkled with fine sand to prevent the clay sticking to it. Sprinkling with sand is preferable as it gives neat and clean bricks with less distortion which dry more quickly as compared to ones prepared from wet moulds (20). The workman throws a rolled clod of clay into the mould and then presses the clay into the corners with his fingers. He scrapes off any surplus clay with a straight edge or a wire and makes the face good with a wet piece of wood. The filled mould is taken to the drying floor where the brick is placed in flat position on the floor and the mould lifted off. The drying floor should be lightly covered with sand to prevent the bricks from sticking to the floor and should have a roof to prevent damage from rain. The bricks can be placed on wooden boards which are arranged one above the other with enough space for circulation, in three or four tiers. After two or three days the bricks should be placed on edge, course above course, and spaced for air circulation as shown in Fig. 38. In dry regions, drying can be in the open and the bricks covered initially with grass to prevent quick drying which may result in shrinkage cracks. It is important that bricks are well dried before they are taken to the clamp for burning otherwise moisture driven out from the bottom course in the clamp is likely to damage the top courses (21). Where the humid climate prevails throughout the year as in the Forestland and Coastal regions of Ghana, drying of bricks is very slow and it may take more than two weeks for the bricks to be sufficiently dry for transfer to the kiln for burning.

There are many different types and methods of building kilns for firing but for manufacturing on a small scale, temporary clamps are recommended; a clamp refers to a packed heap of bricks within which a fire is built. Clamps can be easily and quickly built, their size depending on the quantity of bricks required. The method of construction of a wood-fired clamp can best be understood from Fig. 39.

In building the clamp, the bricks are packed on edge about one finger-space apart in a five-over-two setting, that is five headers over two stretchers. The fuel chambers called the "eyes" are built right through the clamp and brick courses are corbelled to form a self-supporting arch on fuel chambers. The top course of bricks should be packed close without leaving any space between them to form a roof of the clamp. Small spaces, as shown in Fig. 39, should be left in the roof to provide a draught for the fire. When the packing of the bricks has been completed, all the four sides should be covered with mud plaster to conserve heat. The roof and vent holes should not be covered at this stage, to allow water vapour to escape during the first two days after starting the fire.

The fuel used should consist of round dry logs not less than 4 in. in diameter and closely packed with dry kindling chips underneath. After starting the fire, the holes of the fire chambers should be partially closed to keep the burning slow and dull so that water from "green" bricks is driven out slowly. The roof starts shrinking at this stage. After about two days of low fire, the water would have been driven out. The roof is covered at this stage with a layer of loose soil leaving the opening for the draught and the fire is increased to red-hot by adjusting the opening of inlet to the fire chambers. Fuel is added from time to time and the fire kept continuously burning from seven to ten days.

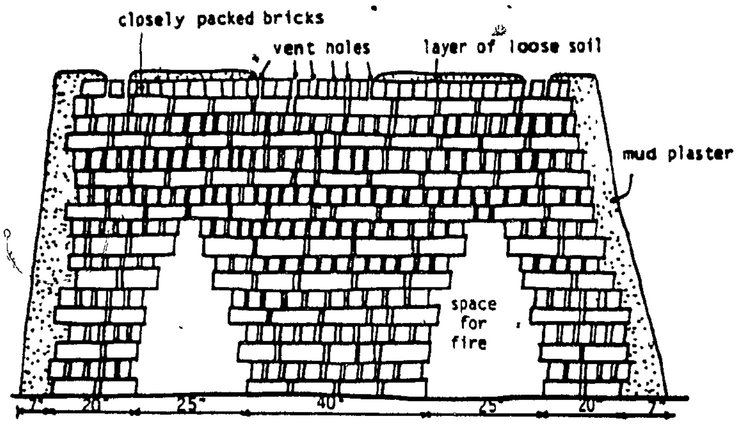
After about seven days, a little piece of plaster at the side is broken to see if the bricks have been properly fired. As the burning progresses and the temperature in the clamp increases, the roof starts sinking gradually, due to the shrinkage of the bricks. Care should be taken to make the roof sink evenly and if some part of the roof is sinking more than the rest, it can be checked by closing the draught hole near it. For this purpose, it is better to spread the draught holes into groups in the roof, four near the corners, and one in the centre. The draught can thus be regulated to maintain the same temperature in different parts of the clamp.

After the burning has been completed, the clamp is allowed to cool slowly for a few days. At this stage, the inlet to the fire chambers should be completely sealed. Cooling time should be as long as possible, but not less than one week. This is because rapid cooling may result in cracking of the bricks. Two or three top courses of bricks may remain underburnt and should go to the bottom of the next clamp.

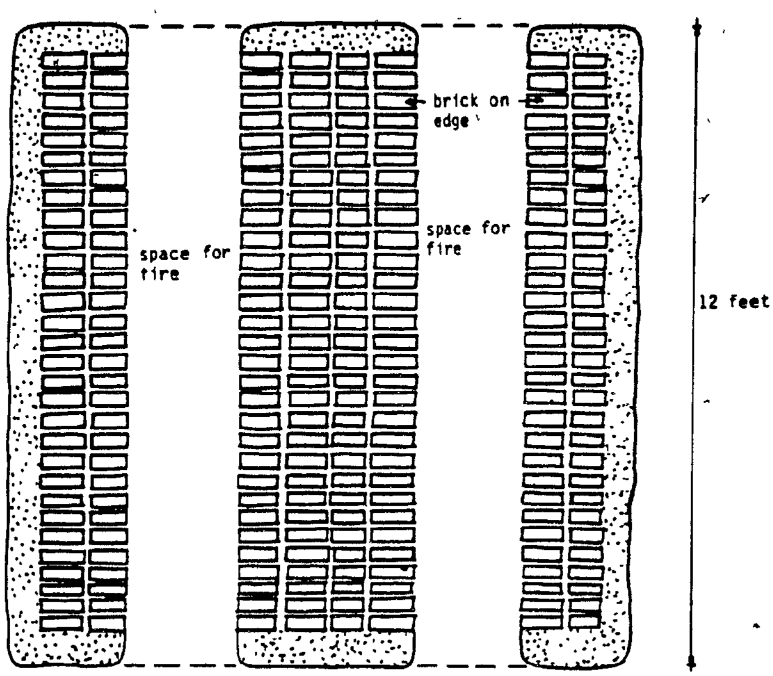
When the clamp is unloaded, the bricks are sorted out and stacked separately into well-burnt, under-burnt and and over-burnt lots. The well-burnt bricks are used for construction, the under-burnt bricks are refired whilst the over-burnt ones can be used in foundations and the interior of thick walls, or broken into aggregate for concrete. If proper care is not taken in loading and unloading the clamp, a high percentage of bricks may be broken but usual breakage is about 10% to 15%.

5.2.2.1 Size of Brick Clamps

The size of a clamp can vary according to the quantity of bricks required and the rate of production or construction at the site. Typically, a total time of about 20 days is required for erection, firing, cooling and unloading of a clamp. For continuous employment of labour the most suitable arrangement would be to start erection of a second clamp when the first is ready for firing; this way two burnings may be completed in one month. A convenient size is 12 ft. x 12 ft. with two firing holes as shown in Fig. 39. The height can vary from 7 ft. - 12 ft.; lower clamps are



SECTIONAL ELEVATION



FLOOR PLAN

FIG.39 WOOD-FIRED BRICK CLAMP.

more convenient for loading and unloading. Bawa further reports that research work has been carried out at the B.R.R.I. with different clamp capacity as follows:

1). 6 ft. x 6 ft. x 7 ft. high ....1,800 green bricks

2).12 ft. x 12 ft. x 7 ft. high.........7,500 green bricks

3).12 ft. x 12 ft. x 10 ft. high.......25,000 green bricks.

Two clamps of the size 12 ft. x 12 ft. x 7 ft. high, yielding about 13,000 sound bricks (after allowing for breakages and wastage), should be sufficient for construction of one unit of a medium size house of two bedrooms and a living room.

5.2.2.2 Cost of Production

In the trials conducted at the B.R.R.I. to collect data on the productivity of labour, and on the costs of firewood and labour in the production of burnt clay bricks, the following estimates of small-scale brick production were achieved. The estimates are based on one production run of 20,000 bricks of the size 12 in. x 6 in. x 4 in. in a month.

Table 6

Estimates of small-scale brick production costs

Activity	No. of Personnel	Estimated Cost($)
Earth digging, clay mixing	3	33.00
Moulding, block making, and carrying of green bricks.	6	66.00
Clamp firemen (erection, firing and unloading)	3	33.00
Miscellaneous (drying and		

stacking)	2	22.00
Foreman	1	22.00
Total	15	176.00

Source: "Manufacture of burnt clay bricks in wood-fired clamps", T.P. No. 6, B.R.R.I., Kumasi 1971.

This works out at a labour cost per brick of $0.01 (assuming 20% wastage). Approximately two tons of firewood were required for burning 1,000 bricks of the size 12 in. x 6 in. x 4 in. with a large frog. With an estimated cost of firewood at $5.50 per ton fuel cost per brick stood at $0.01. This could be compared with standard block production in the following table.

Table 7.

Comparison of sandcrete block and burnt brick production cost

Cost per square foot of wall

Building Material	Size	Retail Price
Sandcrete block	18in. x 9in. x 6in.	$0.18
Burnt brick	12in. x 6in. x 4in.	$0.13

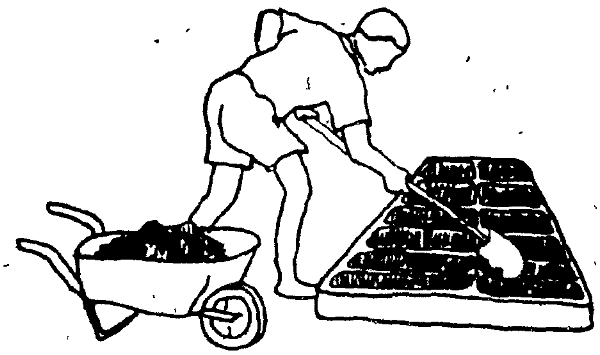
From the above table, it can be seen that the cost of production of burnt clay bricks in small scale units compared favourably with that of sandcrete blocks. At 1971 prices, production cost of a unit of burnt brick was estimated at $0.03 and that of sandcrete block $0.05. The price of sandcrete block does not include the cost of winning the sand, i.e. sand collected by the owner-builder. If the perennial shortage of cement is considered, it could be said that it would be relatively easier and cheaper to adopt the production of burnt bricks for building construction in rural Ghana, using wood-fired clamps. In the trials carried out at the B.R.R.I. firewood had to be purchased from contractors but costs could be further reduced if firewood is cut from the forest by owner-builders.

The assertion can also be made that the technology involved is fairly simple and straightforward and could be easily carried out in the rural areas. The adoption of this technology would mean that owner-builders might participate directly in the production of materials for their own houses at comparatively lower costs.

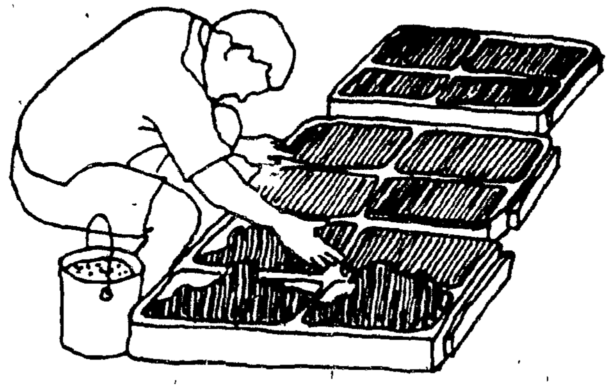
Except in the Northern Savanna where water supply is a problem and boreholes may be required, the other parts of the country have abundance of water. Firewood is easily available in the Tropical Rain Forestland whilst about 290,000 tons of residual oil is available annually from the Ghana Oil (GOIL) refinery at Tema, and Hammond estimates that a hundred tons of fuel is required to produce one million bricks (22). Furthermore, Ghana is favoured with clay deposits in all her regions, from which bricks, tiles, drainage pipes and sanitary wares can be manufactured.

5.2.3. Sun-dried Earth Blocks

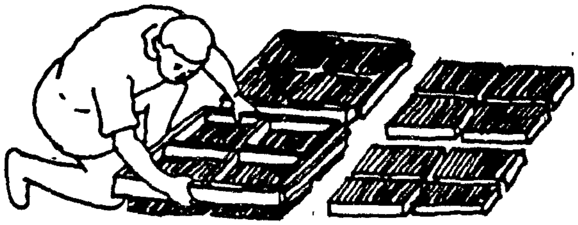
When labour is plentiful, as is the case in rural Ghana, sun-dried earth blocks can be manufactured manually. All the materials needed are forms for moulding the blocks and simple tools for moving and mixing the earth, like hoes,



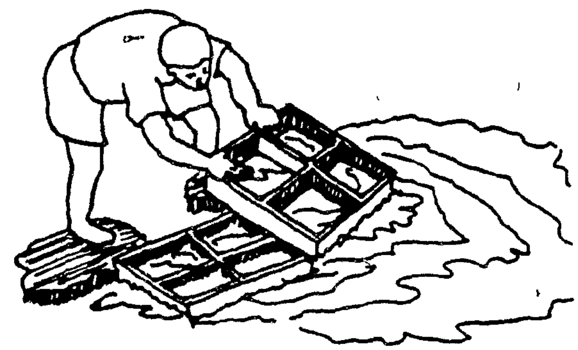
PLACING MIXED EARTH IN FORMS



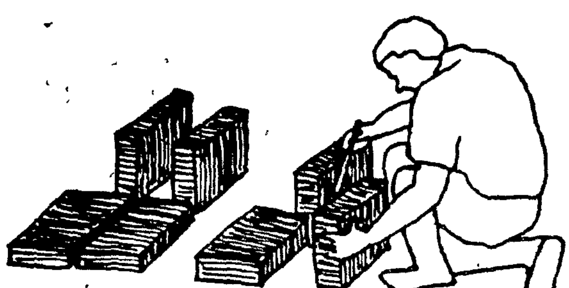
KNEADING BLOCKS WITH HANDS



REMOVING TIMBER FORMS AFTER KNEADING OF BLOCKS



WASHING FORMS AFTER REMOVAL FROM CASTING GROUNDS



REMOVAL OF EXTRANEOUS MATERIALS FROM BLOCKS

STACKING OF SUN-DRIED BLOCKS AFTER REMOVAL FROM DRYING GROUNDS

FIG.40 MANUFACTURE OF SUN-DRIED EARTH BLOCKS.

shovels, headpans and wheel barrows (23). Forms may be made for single blocks, but two-, or four-block forms are better. Strong, long-lasting forms can be made from 2 in. thick planks. Since they will be wet most of the time, it helps to soak the forms in oil for a while before using them. Sun-dried earth blocks can be made almost any size but they should be kept small enough so that one man can lift them without tiring too much. This can be done by an average man if the block weighs about 50 pounds or less.

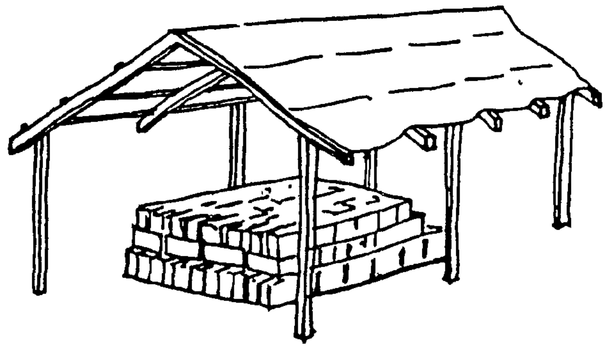
Sun-dried earth blocks are commonly made 4 - 6 in. thick. The width of the block matches the desired thickness of the wall, 9 - 18 in., and the length is controlled by the weight of the block. Two typical sizes of blocks are 5 in. x 10 in. x 20 in. and 4 in. x 12 in. x 18 in.

The manual method is most efficient when four workers are used: two men prepare and mix the soil while the other two mould and remove the blocks then clean the forms. The dry soil is mixed with water until the soil barely flows when lightly kneaded. Bituminous emulsions or other liquid stabilizers can be added to the soil mix at the same time as the water. Dry or powdered stabilizers such as lime and cement can be mixed in before the water is added.

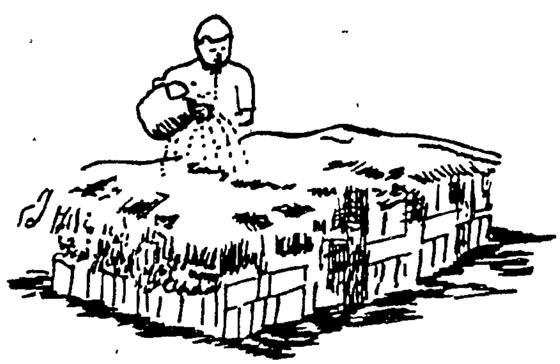
After thorough mixing, the mix is placed in the forms (Fig. 40). It helps to drop or throw the mix in the forms so that it packs tightly. The mix is then kneaded by hand (Fig. 40) to fill all the corners and remove all air bubbles. If the kneading job is done well, the blocks will be solid and have strong corners and edges. After kneading, a small board or trowel is used to cut off the extra soil and smooth the top edge of the moulded block. To smooth off the block, a little water can be sprinkled on top of it. The forms are lifted from the freshly made blocks (Fig. 40). If the blocks slump or bulge too much, either the forms are being removed too soon or the mix is too wet. If the mix sticks to the forms when they are removed, the mix is too dry or the forms have not been oiled enough. After removing the forms they are washed (Fig. 40) and returned to the casting bed for the next batch.

5.2.3.1 Curing Sun-dried Earth Blocks

Sun-dried earth blocks must be cured before they are used. They must be left in place two to four days without being disturbed after the mould is removed. When they are strong enough to be picked up without chipping or breaking, they should be placed on edge to finish curing. Any loose sand or other material clinging to the block is scraped off with a small stick (Fig. 40) at this time. Curing takes about a month, but depends on the weather and the type of stabilizer in the block. If stabilizers such as lime or cement are used, the blocks must be covered with wet cloth or straw as soon as the moulds are removed. The bricks must be kept moist for seven days and then turned on edge to complete the curing (Fig. 40). At the end of the curing period, the blocks are stacked on edge (Fig. 40) so that they will take up less room. A large curing area must be available because of the long curing period. In dry, hot areas, sun-dried blocks



SUN-DRIED EARTH BLOCKS PLACED UNDER COVER.



SUN-DRIED EARTH BLOCKS COVERED WITH SACK MATERIAL AND BEING WATERED.

FIG.41 CURING OF SUN-DRIED EARTH BLOCKS.

can cure without a protective roof. If it is apt to rain during the curing period, a protective covering will be needed (Fig. 41). All types of covering however, must allow air circulation around the blocks or they will take too long to cure.

5.2.4. Small-scale Lime Production

Lime, either slaked or unslaked, makes one of the best stabilizers for clays (24). Lime reacts with clay to form a binder, breaks the lumps in clay down and makes the soil easier to mix. Hammond reports that lime can be produced by burning limestone in kilns with firewood, fuel oil or electricity (25). The use of electricity however, requires sophisticated equipment and a large capital outlay for a viable investment. Firewood or fuel oil-based cottage industries would be more reasonable in rural Ghana.

Four out of the five major deposits of limestone in the country are located at Wenchi and Nauli, in the Tropical Rain Forestland, and also at Buipe and Bongo Da, both in the Northern Savanna (26). Lime and lime-pozzolana have been used as a cementing material since ancient times. The Egyptians used it for plaster and the Romans used it extensively for mortar and plaster, and for making concrete. Unfortunately, lime has mainly been used for white-washing walls in Ghana and the full cementitious properties of lime have not been taken advantage of. At the same time, production presently meets less than a quarter of the demand of the local market.

In India, up to the 1930s, lime together with surkhi (lime-pozzolana) had been the principal cementing material; magnificent palaces, massive forts, dams, bridges and other structures built in lime and surkhi have stood for centuries and are still intact (27). Lime, lime-pozzolana mortars and plasters possess good workability and plasticity, negligible volume change, good compressive strength, adjustment to stresses in the masonry in the course of time due to slow setting, improvement in strength continuously with time, and restrain efflorescence.

Village lime production has been carried out in India for generations using intermittent kilns of the "country" type (28). These are rectangular, about 20 ft. x 13 ft. in plan and about 13 ft. high. Part of the kiln is usually below ground and part of the projecting portion is contained within massive stone walls set in mud mortar. The fire holes, which are opposite each other in the long sides, are connected by flues set into the floor of the kiln. The internal walls are plastered with mud before each firing. The kiln is filled to a height of about 3 ft. above the top of the walls with alternate layers of limestone (approximately 1 in. thick pieces) and firewood (to be used in Ghana instead of the coal used in India). The fire slowly rises through the bed over a period of about 20 days. The lime can be sold in this condition and slaking done at the building site.

The slaking of lime is an important process and great care should be exercised to slake lime completely. Lime should be freshly drawn from the kiln for slaking preferably within seven days of its calcination. All extraneous kiln ash must be removed from the burnt lime before slaking. During slaking, lime expands considerably and therefore if any portion of it comes into the mortar unslaked, it will slake subsequently, thereby expanding and causing damage to the masonry walls. Two methods of slaking are recommended on account of their simplicity and economy. These are tank slaking and platform slaking.

For tank slaking, two brick-lined tanks are required. The first tank is about 18 in. deep and is made at a higher level, generally above the ground level. The second tank is between 24 - 30 in. deep and is made at a lower level which may be below the ground level. The higher tank is filled with water to a depth of about 12 in. and quicklime is gradually added to it so as to cover the entire bottom of the tank to about half the depth of water. While quicklime is being added, the water is constantly stirred and hoed. No part of the lime is allowed to get exposed above the water. It is very important that in slaking, lime should be added to water and not water to lime, otherwise slaking will not be effective. As the lime slakes, with the evolution of heat, the water begins to boil; more lime may be added till the requisite quantity of lime is slaked. After the slaking is over, stirring and hoeing should be continued for some time further to make sure that the whole of the lime has been fully slaked. Milk of lime thus formed is allowed to flow through a 1/2 in. mesh sieve into the lower tank where it is allowed to mature by standing undisturbed. This forms what is called lime putty.

Milk of lime during this process loses moisture by evaporation and thus thickens. For maturing of putty, about 2 to 3 days should be allowed. This ensures complete slaking and at the same time improves the workability. Putty should not be allowed to stiffen or dry till it is used. To obtain a continuous supply of putty, two lower tanks instead of one can be used alternatively so that when putty is being used from one tank, fresh putty can be made in the other. When quicklime is received from the kiln in very large lumps, it is expedient to sprinkle on the heap a small quantity of water before putting this quicklime into the tank for slaking. This breaks the bigger lumps into smaller ones for convenience of handling.

In platform slaking, quicklime is spread in a 6 in. layer on a watertight masonry platform and water is sprinkled over it in small quantities through a watering can or with a hose until the lime disintegrates to a fine powder. As water is added the heap of lime is turned over and over. Care should be taken that minimum amount of water is added as is required for complete slaking. Slaking should be allowed to continue further itself for a period of 24 hours. It should then be screened through a 1/8 in. mesh sieve. Slaked lime should be stored in a dry place under cover and well protected from rain.

Quicklime should be turned into putty or dry hydrated lime as soon as possible after delivery as it deteriorates quickly when stored. It attracts moisture and carbon dioxide from the atmosphere and ultimately reverts to its original composition, calcium carbonate. In doing so, lump quicklime falls to a powder, and becomes what is known as air-slaked, thereby losing a great deal of its useful properties. Particular care should be taken to ensure that quicklime is kept dry. These precautions apply equally to lump quicklime and ground quicklime. If unslaked lime is to stored for a short time it should be piled up and covered with a blanket of lime dust to exclude moist air. Dry hydrated lime on the other hand, can be safely stored for a considerable period without deterioration with the simple precaution that the bag should be kept in a dry place.

Slaked lime also deteriorates in quality gradually by absorbing carbon dioxide from the atmosphere. Lime should be used as soon as possible after it is slaked, and should not be kept in storage for more than two weeks. Deterioration of slaked lime however, can be reduced to some extent by covering the heap with a layer of bricks.

From considerations of strength as well as economy, lime is mixed with certain aggregates such as sand and cinders for use in mortar. Normally the proportions of lime and aggregate employed are 1 part of lime to 2 - 3 parts of aggregate. A sharp sand is necessary for mixing with lime if strength required and a poor sand can be used for secondary non-load bearing work.

For a finishing coat of plaster in lime, certain precautions must be taken. The sand must be all finer than

64 mesh to an inch. The strength and quality of the mortar or plaster depends on the method adopted for mixing. There are essentially two methods adopted for mixing lime mortar: manual mixing on a platform or in a masonry tank, and grinding in a mortar mill run either by animal or mechanical power. For the purposes of this thesis, only the former method would be examined.

For manual mixing of mortar, measured quantities of slaked lime in a powdered form (or as a putty), pozzolana and aggregate are placed on a watertight masonry platform or in a small tank. The ingredients are first mixed by turning over two or three times with a spade. Water is added and mixing is further continued till a mortar of uniform consistency is obtained. To obtain continuous supplies of mixed mortar for large works, two tanks can be provided for alternative use. This way, while mortar already prepared in one tank is being used, mortar could be mixed in the other. Lime mortar should be used as soon as possible after mixing. No mortar should be kept over 72 hours.

The B.R.R.I. reported in 1974 that the cost of imported lime was \$103 per ton (29). This can be compared to that produced locally which was \$39 per ton. At the same time the cost of cement was \$99 per ton. Clinker importation (for the manufacture of portland cement) alone consumed a quarter to almost one-third of foreign exchange resources on building materials in 1974. The cost per square foot of mortar joint for brick wall was \$0.14 and that for sandcrete block wall was \$0.09. Assuming a 10% annual inflation rate puts the 1984 cost of locally-produced lime at $101 and this suggests that the cost of mortar joints for brick and sandcrete block walls will respectively be $0.14 and $0.09 per square foot. The use of lime for rural housing construction can be economical.

5.3. Financing Rural Housing Improvement

The low income levels in rural Ghana have been noted. Low incomes affect the rate of housing construction, the quality of the housing unit, and the adequacy of amenities provided to make a decent living environment. With low incomes and high living costs, rural dwellers have had to resort to cheap materials and inefficient construction techniques. The result has been houses that are not durable. Methods for the production of more durable building materials through cottage industries discussed above need some kind of financing. A way of financing rural housing to allow for improvement of traditional construction techniques without raising costs substantially would have to be found. In "Housing Financing in Rural Ghana", Afele states that 91% of the people interviewed in the 1973 rural housing survey used their own sources of income to build their houses and only 5% had financial assistance from relatives (30). This suggests either the lack of access to credit facilities to rural dwellers or that such credit facilities are not needed. Poverty among rural Ghanaians has been noted and together with the absence of collateral security, the former appears more convincing. Improvement of rural housing through the introduction of more durable building materials and construction techniques, implies that the rural dwellers would have to spend more on housing. This could mean the need for loans and credit facilities for low income families for whom the formal banking sector is unknown. Community associations could make it easier to supply the necessary guarantees and foster repayments. The establishment of savings and loans associations and other local credit mechanisms that would be adapted to the rural situation could be useful.

5.3.1. Rotating Savings and Credit Associations

Nevin states in "Capital Funds in Underdeveloped Countries", that "The poorer a country is, in fact, the greater the need for agencies to collect and invest the savings of the broad mass of persons and institutions within its borders" (31). In their joint paper, O'hlliginn and Ortiz suggest that certain minimum levels of income are necessary in order to undertake the commitment involved because of the economic cost of house building (32). They further state that this calls for a threshold of income which provides the minimum possibility to undertake housing improvement.

One means of reaching this threshold of income in rural Ghana would be to create an avenue for the people to pool their scanty household incomes together. This could be realized by the formation of rural savings and credit associations. Throughout rural Ghana, there are rotating savings and credit associations, locally known as "susu", with common goals which have included coverage of funeral expenses (funerals are very expensive anyway), purchases of building materials, and educational expenses of wards. These associations could be utilized to improve the incomes of rural dwellers to enable them improve their housing conditions. How do these associations operate ?

The operation of this type of association is vividly described by Levin in the unpublished report, "Some aspects of the housing situation and housing problems in Benue State, Nigeria", in which he mentions that small informal savings associations are widespread in West Africa (33). Membership is open to residents of the settlement and savings goals are established which are binding on each member. Individual contributions of fixed amounts, which may vary from one place to another and range from $0.25 to $1 per week, are collected at each meeting, or by an official who moves from house to house, or around the village market. The combined contributions go to each member in turn, and the total amount given to each member and the 'terms of the loan' i.e. how much a member gets, what the interest rate is, and how the loan is to be paid back, are determined by the number of members as well as by the amount contributed by each member. The term or complete cycle of the club is determined by the number of members and the frequency of meetings.

The club dissolves when every member has had a turn. Failure to honour the savings is punished by fines agreed upon at meetings or even by expulsion from the association.

Members cite several attractions as reasons for belonging to the associations. These include the sociability of the group, the constraint placed on withdrawals in comparison with savings accounts in the formal sector banks, and the relative ease in getting loans compared to the difficulty in getting loans from formal sector banks.

The sociability and ritual form of these groups is striking. The groups demand certain kinds of participation and members attending meetings follow prescribed forms of etiquette. Lateness is discouraged by fines and contributing to the discussions, entering or leaving the meeting for example, all have to be permitted by the chairman. A very friendly atmosphere characterizes the meetings and provides a diversion from the more serious business at hand. A member can only withdraw his savings at fixed dates which occur only once or twice a year, at the end of the term, depending on the association's regulations. Any other attempt to withdraw funds must be explained and adequately justified and reasons can be queried publicly at the meetings. Members see such public airing of reasons as a significant restraint which discourages the easy withdrawal of savings.

The great potential that these voluntary savings and loans associations have in rural housing projects, especially as agents through which savings can be mobilized, cannot be underestimated. Particularly prominent features making them suitable for rural housing improvement schemes are encouraging the people to save for specified targets and training them in simple accounting skills. By the end of the full cycle, the savings association guarantees that all members would have paid a minimum down payment which would be derived from their turns in the rotation. The experience gained in such a group might lead to a continuation of the group with specific house improvement goals as a distinctive condition of group membership. The routine of the groups in itself could provide the training as a part of the overall savings experience since these groups have routinized procedures and record keeping. Most members are familiar with the recording and accounting procedures. The record keeping practices of these groups might seem over elaborate and unnecessarily duplicated but such devices ensure accountability. They also reduce the possibility of collusion and fraud by officers. Such groups also could be very efficient means of disseminating information for regular meetings, and provide a forum for discussions and transmission of information. The autonomy of the associations must be maintained to ensure that they are self-supporting. Even minimal involvement by officials, particularly the central government, could easily lead either to dependence or to alienation of the associations' members.

These associations invariably tend to charge higher interest rates than the formal banking sector. Whilst interest rates of the formal sector banks are around 10% per annum, they could be as high as 20% or 30% in these associations. Rural farmers have also been known to pay even higher interest rates on loans from money lenders to develop their farms. This suggests that rural dwellers would be prepared to pay more economic interest rates on credit and loan facilities specifically geared towards housing improvement.

The proposal then is to form more of such savings and credit associations with rural housing improvement as the sole goal. This will enable rural dwellers to generate income for the improvement of their own houses, allow them to participate in the process and also open up credit facilities to them. These associations could buy shares in the small-scale building materials industry to ensure the continued availability of materials.

5.3.2. Credit Facilities from the Rural Banks

Another way of advancing credit to the rural population to improve rural housing is the new Rural Bank. Since 1980, the Bank of Ghana has been opening banks in rural Ghana. The Bank of Ghana sells shares in the rural areas to people. When the sales reach a minimum amount specified by the Bank, a branch office is opened in the locality and directors elected by the shareholders. Successful businessmen who hail from the locality but reside in the cities are eligible to purchase these shares. Rural banks established at Biriwa, Elmina, and Mampong Akropong in 1980 were able to raise over $10,000 each. These banks do not demand as much collateral security as those in the formal sector banks do. They also do grant very small loans such as $30 - $50. Loans as small as $30 have been granted to farmers, to enable them to purchase seeds and tools, with only the farmland as the collateral. In some cases, these farmlands may only have been rented by the farmers. Interest rates charged are at 10% per annum.

These rural banks could advance credit facilities to rural dwellers to enable them produce building materials through cottage industries. Such credit facilities could be extended with repayments scheduled for the harvesting season. The banks could even buy shares in the cottage industries to ensure continued production.

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CHAPTER 6

CONCLUSIONS

The purpose of this thesis is to review rural housing conditions in Ghana, explore the possibility of improving the situation, and discuss methods for solving the problems. Traditional houses built in indigenous materials are not durable. Lives have been lost during the rainy seasons, particularly in the Tropical Rain Forestland, where houses have collapsed on the occupants.

The main disadvantage with the traditional earth buildings is their rapid deterioration under adverse conditions. The available literature on earth buildings abounds with information on different methods for preventing this shortcoming; many constructional methods and remedies found successful in various places have been documented. The affordability of the individual technologies which have been described would now be examined.

6.1 IMPROVED FOUNDATIONS

Using the typical Ashanti courtyard house as an example, with a built area of 1,220 square feet, the cost of the brick component alone in a one-piece tapering foundation is \$300 (using a retail price of \$0.13 quoted by the B.R.R.I. in 1971 and assuming an annual inflation rate of 10%). If the assumption is made that the broken bricks would sell at half the retail price, the new cost is \$150. On the other hand, if the broken bricks are manufactured by the owner-builder, assuming the same production costs, this is further reduced to \$72. If two tons of lime are utilized at \$92 per ton, (using 1974 quoted price of \$39 per ton and assuming 10% annual inflation rate), the total cost of the foundation is under \$400. This can be compared to the foundation cost of the B.R.R.I. "low cost" courtyard house, of an area of 2,100 square feet, which was \$768 in 1971 and becomes \$1,770 in 1984. It is important to note that this is still about 15% cheaper than that of the foundation of a conventional house.

However, if stones are used, the picture changes considerably. If the stones are collected by the owner-builders, or by a common pool supplying all the building sites in the locality, the only costs incurred would be for purchasing lime for the mortar. For the courtyard house under consideration, assuming two tons of lime are used, the cost of the stone foundation stands at under \$200. In areas where stone deposits are plentiful, stone foundations would probably be the 'ideal' solution for they are both economical and very durable.

6.2 WALL CONSTRUCTION

A variety of materials have been considered for wall construction in rural housing improvement. Cost analysis of these materials would be considered using the typical Ashanti courtyard house (Fig. 11).

6.2.1 Wall in Burnt Bricks

The courtyard house in Fig. 11 covering an area of 1,220 square feet has a gross wall area of 2,000 square feet, without the openings. At 1984 retail price of $0.30 per brick, the cost of bricks alone is $600 and with the cost of lime mortar at $1.20 per square yard, the cost of 3/4 in. thick mortar joint is $270. The total cost of the walls is $870.

However, if the owner-builder produces the bricks at the same production costs as the B.R.R.I., at $0.20 per brick, the cost of bricks reduces to $400 and the total cost of the walls is $670.

These costs can be compared to that of the "low cost" brick house built by the B.R.R.I. at $5,300 (1984 prices) for only the walls of the 4-room house. The use of burnt bricks manufactured locally by the owner-builder, will result in cheaper houses in the rural areas.

6.2.2 Rammed Earth Wall

If it is assumed that because of considerable abuse about five sets of timber forms would be needed to construct the house in Fig. 11, at $0.80 per cubic foot, the total cost of lumber is $80 (for a form 4 ft. x 2 ft). If 4 tons of lime are used as stabilizer at $92 per ton, the total cost of the walls is under $450. This is cheaper than the same house constructed in bricks, though brick walls are easier to build. Rammed earth construction for rural housing improvement could be described as economical.

6.2.3 Sun-dried Bricks

The tools needed for this type of construction are timber forms, stabilizer and clay. If the same estimates are made for the cost of timber (for the forms) and lime, as in rammed earth construction, the cost of the bricks in the house in Fig. 11 is about $400. With the cost of lime mortar, this increases to $670 for the house in Fig. 11. Rural house construction in sun-dried bricks or blocks could be economical.

6.2.4 Soil-cement Blocks

Using the results of the Tanzanian experiment, (there are similar conditions in the two countries), the cost per square foot of soil-cement blocks is $0.42 and the total cost of the walls in the house in Fig. 11 is $1,110 including $270 for lime mortar. Though more expensive than the other alternatives, it is still cheaper than conventional housing construction. Coupled with the difficulties inherent in the procurement of cement, soil-cement blocks for wall construction is the least economical of the various technologies considered.

6.3 Plastering House with Lime Mortar

The cost of 1/2 in. thick cement-sand plastering in 1974 was $0.65 per square yard and with an annual inflation rate of 10%, this becomes $1.70 in 1984. For the house under consideration, with 222 square yards, cement-sand plastering cost is $375. The cost ratio of cement to lime is 2.5 : 1, and that means the cost of plastering the house with lime is

$150. Plastering houses with lime in rural housing improvement projects in rural Ghana is more economical.

In all the economic considerations, no allocation has been made for labour costs and this is because housing in rural Ghana is mostly owner-built. The assumption is also being made that the proposed vocational training in the rural areas would enable rural dwellers to adopt improved construction techniques and therefore would not need to hire artisans.

The legal minimum wage in 1984 is $420 per annum (1). Using this, and allowing 25% for housing, a rural dweller can afford a house which costs about $530, assuming a 10 year, 10% interest loan. The cost of the improvements to the house considered varies from $450 for rammed earth walls to $1,100 for soil-cement walls. Note should be taken of the fact that the house under consideration has six rooms while the average cost of $300 recorded in the 1973 Rural Housing Survey was for a four-room house; the expensive B.R.R.I. "low cost" house also had only four rooms. Reducing the number of rooms in the house in Fig. 11 to four results in a new built area of 1110 square feet with a gross wall area of 1600 square feet. This produces the following cost estimates; the stone foundation is $160 and brick foundation is $270. If it is assumed that the broken bricks would sell at half price, the new cost is $140 but becomes only $70 if bricks are manufactured by the owner-builder. The cost of plastering the four-room house, of 180 square yards, with lime is $120. The total cost of the house in soil-cement blocks is $880 and that of walls in burnt bricks is $690 but reduces to $530 if produced by the owner-builder. For sun-dried brick walls, the cost of the four-room house is $530 but rammed earth walls cost $360. The total cost of the improvements to the four-room house (with the two end rooms of the northern wing removed) now varies from $360 for rammed earth walls to $880 for soil-cement walls. The production costs of the improved materials could be lower than the estimates used; for example, in the production of burnt bricks, assumptions made include the purchase of firewood but this cost element could be eliminated completely by the owner-builder in rural Ghana. Whereas the cost of improvements in soil-cement blocks and purchased burnt bricks is expensive to the rural dweller, the cost of improved houses in stone foundation, rammed earth and owner-produced brick (burnt and sun-dried) walls, with lime mortar plastering is affordable.

From the foregoing discussions, most of the technologies described could result in cheaper and affordable improved rural housing in Ghana. This is more so when compared to the so-called "low cost" and conventional housing programmes undertaken in rural Ghana. Any rural housing improvement project in Ghana can only be successful if it involves the rural population. This involvement should include the production of substitute building materials in the rural areas, as has been outlined in this thesis.

6.4 The Role of Small-scale Building Materials Industries

Rural housing improvement in Ghana cannot proceed along the same pattern as in the urban centres. A complete transfer of modern and conventional building materials and construction methods, from the urban to the rural areas will not happen overnight, or even in the immediate future. At present income levels, it is simply impossible to expect that modern durable houses can replace present rural ones soon. What is needed are more durable building materials, and methods to improve rural housing. This blend is what small-scale building materials industries seek to achieve.

Small-scale industries producing building materials have had a role in rural housing improvement projects in some developing countries. To quote Rybczynski, "China has shown how small-scale industries can play an important role in rural development and how their aggregate effect on national growth is not inconsiderable" (2). In India, lime production on small-scale in intermittent kilns of the 'country' type have been a steady source of the cementing material for several decades (3).

Small-scale production of building materials has several advantages. It allows the active involvement of the rural population. It is logical because all the necessary inputs are locally available. The building materials can also be produced at the rural dwellers' own pace. In rural Ghana where most people are owner-builders, this is very convenient.

The prices of the materials to be produced from these cottage industries would not be as expensive as factory-made products. Transportation costs which presently contribute significantly to the overall buiding costs would be reduced considerably. Together with a locally-available skilled labour force from the vocational training programmes outlined in this thesis, small-scale production of building materials could be a big step towards improved rural housing. Another side effect of this development will be that the urban immigration and consequent pressure to produce housing in the cities would be reduced. If a man remains on his own land, his house is his own responsibility: if he migrates to the city, the hard pressed municipal and central government administrations face the problem of doing something about his housing requirement.

The approach being discussed here for improving rural housing in Ghana is one which seeks to incorporate relevant modern construction technology in traditional building practices. This is not a case against modernization. Rather, the use of rural small-scale industries is a viable long-term solution to the housing needs of rural Ghana. It is a solution which takes into consideration the health of the Ghanaian economy. It is also based on the maximum utilization of locally available materials. Rural small-scale methods of producing building materials and construction of houses have been proposed after an investigation of how affordable improved techniques can be used to process local materials into more durable building materials.

Small-scale technology measures, largely through cottage industries have been successfully used to produce affordable and durable building materials. Some successes in this respect have been achieved in certain developing countries: village lime production in India, cooperative housing scheme using soil-cement blocks at Tema in Ghana, and the Gourna village housing project in Egypt (4). The use of soil-cement blocks to reduce final building costs in Tanzania has also been noted.

The enormous housing problems resulting from present traditional construction practices need to be addressed now. Rural dwellers have provided themselves with whatever housing facilities they have. They need to be encouraged and helped to improve their housing situation. This is what the measures discussed in this thesis, and utilizing small-scale technology methods, seek to do.

"Finally but probably most importantly, rural small industries are part of an overall strategy for narrowing the gap between the city and the countryside, an endemic problem of most less developed countries" (5).

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