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WORKING GROUP No. 5

APPROPRIATE TECHNOLOGY FOR THE PRODUCTION OF CEMENT AND BUILDING MATERIALS

BUILDING MATERIALS AND COMPONENTS

Background Paper

id 78 6826

BUILDING MATERIALS AND COMPONENTS

by

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* This paper was prepared by J. P. M. Parry on behalf of ITDG.

Preamble

This paper considers important aspects of the economics and technology of the construction sector in less developed countries. It then applies the lessons drawn from the analysis to suggest future policies.

The design and erection of buildings to fit their purpose and the industrial manufacture of building materials are different types of activity but strongly influence each other. The earlier parts of the discussion concentrate on aspects of design from which stem particular requirements for building materials and components.

The paper begins by exploring the background, identifying the main contrasts between the way the rich and the poor construct their dwellings in ldcs and the wider implications this appears to have on their economic livelihood. An objective is then set that, for reasons of both amenity and breaking through the poverty cycle, the main effort of researchers should be channelled into ways of achieving greater durability in the building structures of the poor, especially those in rural areas. The impossibility of achieving this objective by conventional means is emphasised in the context of the huge differences which exist between the amount of money expended at the two extremes of the range of house building technologies. The architectural questions of relative convenience, comfort and sanitation are not considered in any detail in this paper but minimum acceptable standards and fitness for purpose are assumed as the starting point to the technical, economic assessments.

To begin the technical discussion some traditional low cost ways of extending the life expectancy of normally non durable structures are briefly reviewed in the context of an examination of the normal agents of decay in buildings. In particular, opportunities are explored for limiting the use of expensive coating or stabilising materials by only applying these in the parts of the building which are likely to be exposed or vulnerable to attack. The argument then moves on to discussion of the roof in its vital role in protecting the rest of the structure. The main alternative systems are assessed with the conclusion that the problem is far from solved, again especially for the rural poor. Their central problems of low cash income in the face of the higher price they often have to pay for roofing materials are assessed. This in turn pinpoints the great need for a small scale manufacturing process which can produce a lightweight weatherproof sheet material at a low cost. Information is provided of one new manufacturing system which promises to go at least part of the way to meet this need. This is a technique for making low cost fibre reinforced cement roof sheets by hand which is suitable for village-scale industries.

To help identify how such new technologies might be successfully introduced into rural areas a fairly detailed examination is made of the one building product which is manufactured extensively in small scale plants in a wide range of ldcs - burnt clay bricks. Aspects of the brickmaking technologies and operating set-ups are examined to try to determine what features have made them so resilient where so many more capitalised enterprises have failed. The lesson is drawn on how 'more efficient' larger scale enterprises even in the same brick industry tend to run into trouble in conditions of fluctuating market demand, and what this should mean for future investment planning for brick and tile manufacture. An incidential aspect of mechanised production which could be important to many economies is that it calls for far more imported resources than those used by the labour intensive industries.

Discussion of rural brickmaking is concluded in an assessment on how it could be improved technically so as to serve its market with better quality products in manufacturing plants which use resources more efficiently, are less vulnerable to seasonal changes and provide a better operating environment for the workforce. The measures suggested should not only improve the viability of the small production plants but should greatly enhance the service they give to the building industry by enabling them to market better shaped products which save cement, and also to continue production for longer periods thus reducing the seasonal shortages of bricks which occur in many countries.

The argument is then broadened using information on the strengths and weaknesses of the rural brick and tile industries to give guidance on how other forms of building material manufacture could be encouraged. Finally the question is explored of how rural employment and prosperity through expanded building materials manufacture, could be aided by institutional assistance through public sources.

The paper concludes with a description of actions and programmes which, in the light of the technical and commercial findings, might be considered for implementation on an international scale.

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CONTENTS (CONTINUED)

Background

The dominance of the human species over all parts of the Earth, in climates frequently hostile to other forms of life, has resulted mainly from two sectors of technology; clothing and building. Man's ability to protect himself from extreme heat and cold and from exposure to dust and excessive precipitation has derived from his manipulation of natural materials to make protective clothing and shelters, without which he could not survive seasonal extremes of climate. This paper concerns itself with building and in particular the materials that are manipulated or procured into forms used for protective structures.

Building materials can generally be classified into three usage categories:-

1. Materials for the basic structure
2. Protective and decorative finishes
3. Fixtures and fittings.

The main distinguishing feature between the specification of building in a subsistence economy and that in a richer, consumer economy, is the proportion of the total cost applied between these three categories. In the poorest communities virtually all expenditure of resources on building goes towards materials for the basic structure, i.e. for the walls and roof. By contrast, in a prosperous community the cost of the walls and roof of a dwelling may amount to less than a fifth of the overall cost, the remaining four fifths being spent on finishes and especially on fixtures and fittings and the associated services.

The second distinguishing feature is not unconnected to the first. This is the relative durability of the materials used in constructing buildings by the different economic groupings. It is commonplace for the structures of the poorest sectors to last just a few years and in some instances,of houses made up of grass and corn stalks,the life of the structure may be only a year. On the other hand, the wealthy builder tends to build ever more permanently the more disposable income he has. Examples of buildings erected by some of the world's most opulent people have been shown to last hundreds or even thousands of years after their death. There is an irony in this contrast and this is that, in the workings of economics, permanent structures increase in value with age whereas non permanent ones depreciate away to nothing. As a result of being able to build permanently the rich builder gets richer while the poor builder gets poorer as his original investment deteriorates with age as illustrated in Plate 1. on page 3.

Objective

If there were any single course of action likely to break into the poverty cycle of many of the world's poorer communities it would be the facility to make their dwellings at least last out their life-times. Once their dwellings become a store of value and an appreciating asset, the people concerned enjoy a triple benefit:-

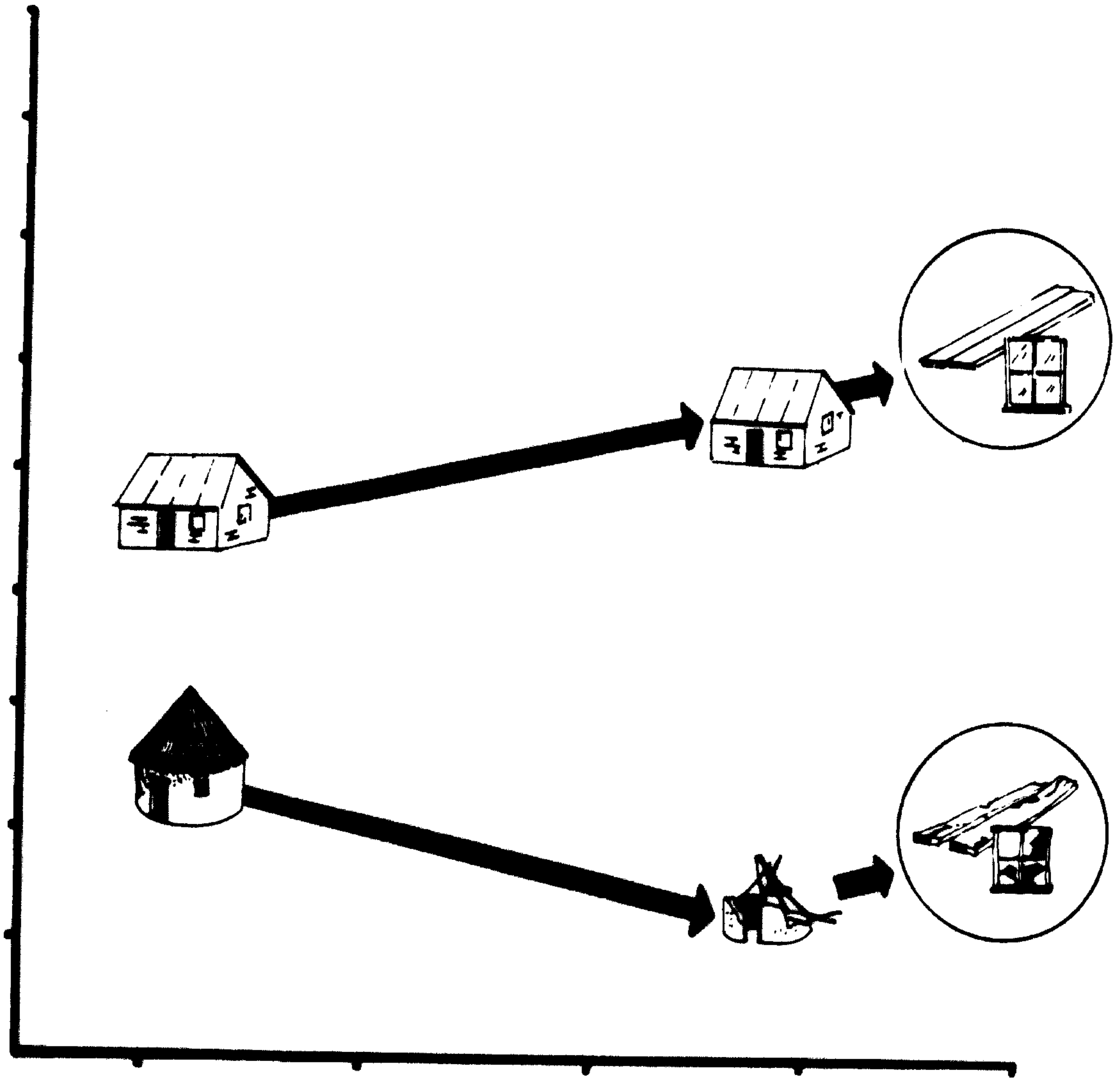
a) The time that they needed to spend in continual maintenance and eventual replacement of their non durable dwelling would be freed for income generating activities.

b) The part of the original structure which entailed expenditure of money but became spoiled as part of the general decay of the structure would in many cases have a long life span if incorporated in a more permanent building.

c) As the dwelling itself increased in value because of its durability, it becomes a source of useful capital if the householder puts it up for sale. Otherwise, in the event of the owner's death, the value of the dwelling passes to the next generation, the most significant form of capital accumulation by the middle classes in many societies.

PLATE 1.

WITH TIME, DURABLE DWELLINGS INCREASE IN MONETARY VALUE AND CONSERVE MATERIALS - NON DURABLE DWELLINGS DIMINISH IN VALUE AND SPOIL MATERIALS WHICH COULD IF USED DIFFERENTLY HAVE A LONGER OPERATING LIFE



An important element influencing the care and attention put into the upkeep of a dwelling is whether the householder has any security of tenure of the land. The investment in better materials and the physical effort to improve a structure is clearly not worthwhile for a family facing the possibility of eviction from the land they are occupying.

It should therefore be a principal objective for organisations working in the field of appropriate industrial technology to seek ways of manufacturing building materials which are durable, at low cost. The low cost element is especially important where it relates to the use of resources of capital, material, or sophisticated skill, and less important where it relates to the employment of labour which would otherwise be unemployed. In other words, in devising construction technologies for the poorer communities, great care should be taken to avoid expenditure of resources that come from outside the community, because it is the lack of disposable income which is the major constraint on all economic activites in a subsistence economy. It is no solution to suggest better ways of building which require significant cash expenditure, because this is the one resource that is always in scarce supply.

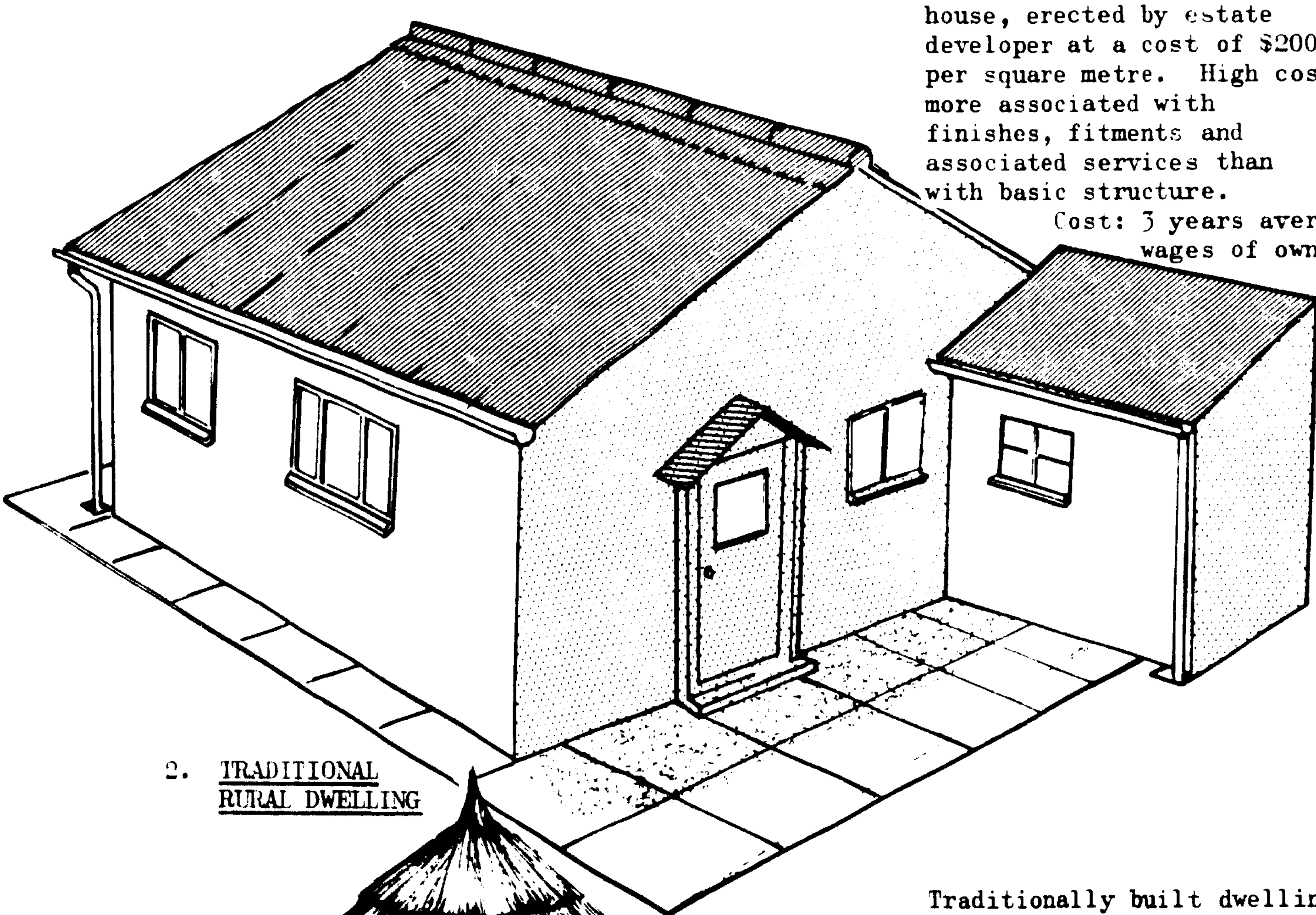
Relative Building Costs

Before attempting to bridge the gap between the non durability of traditional structures and permanent conventional ones, the fact must be faced that just not enough capital resources exist in the world to construct a dwelling for everyone at the cost of conventional building today. The difference in cost per square metre of a conventionally constructed building and a traditional unit is not just a few percentage points, it could be as great as a hundred times more. To take a very broad example, current house building costs, using conventional materials and built to conventional standards, now amount to at least $200 per square metre in many countries. Meanwhile, a simple African hut or shanty dwelling in Central America may occupy a floor space of 20 or 30 square metres, but the total cash expenditure on the whole structure could be as little as $50 or $60. Therefore the basic dwelling unit for many rural and urban fringe communities requires an outlay of only about $2 per square metre, compared with $200 per square metre for conventionally constructed dwellings, as shown in Plate 2. on page 5. There will be many examples which will differ considerably from these broadly based figures but what generally will not alter is the extreme difference between the cost of conventional and traditional building. Therefore, as the proportion of permanent dwellings is so small in the total sum of the developing world's buildings, it is economically out of the question to find sufficient resources to

PLATE 2.

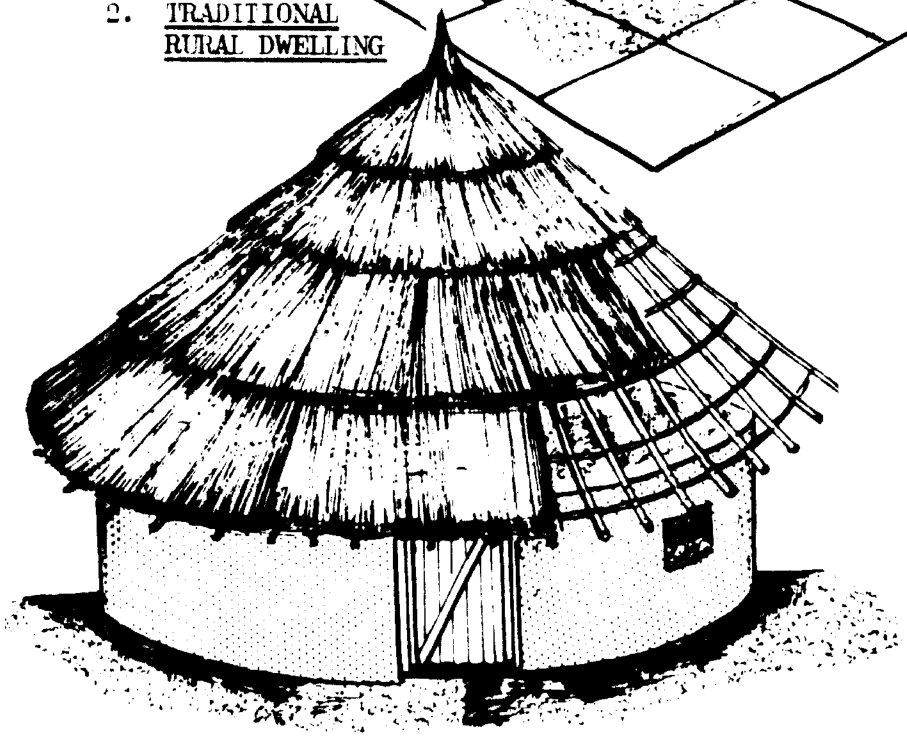
COMPARITIVE FEATURES OF LONG LIFE AND SHORT LIFE DWELLING STRUCTURES

1. CONVENTIONAL URBAN DWELLING



Conventionally built suburban house, erected by estate developer at a cost of $200 per square metre. High costs more associated with finishes, fitments and associated services than with basic structure.
Cost: 3 years average wages of owner.

2. TRADITIONAL RURAL DWELLING



Traditionally built dwelling mainly owner-constructed with site materials.
Limited cash outlay required except for roofing framework and door and window.
Little spent on finishes and virtually nothing on fixtures and services.

Total cash expenditure usually equivalent to under 6 months wages.

Floor area 20 - 30 square metres
cash expenditure around $2.00 per square metre
expected durability, 3 - 5 years

up-grade all the rest to the same standard, using conventional technology.

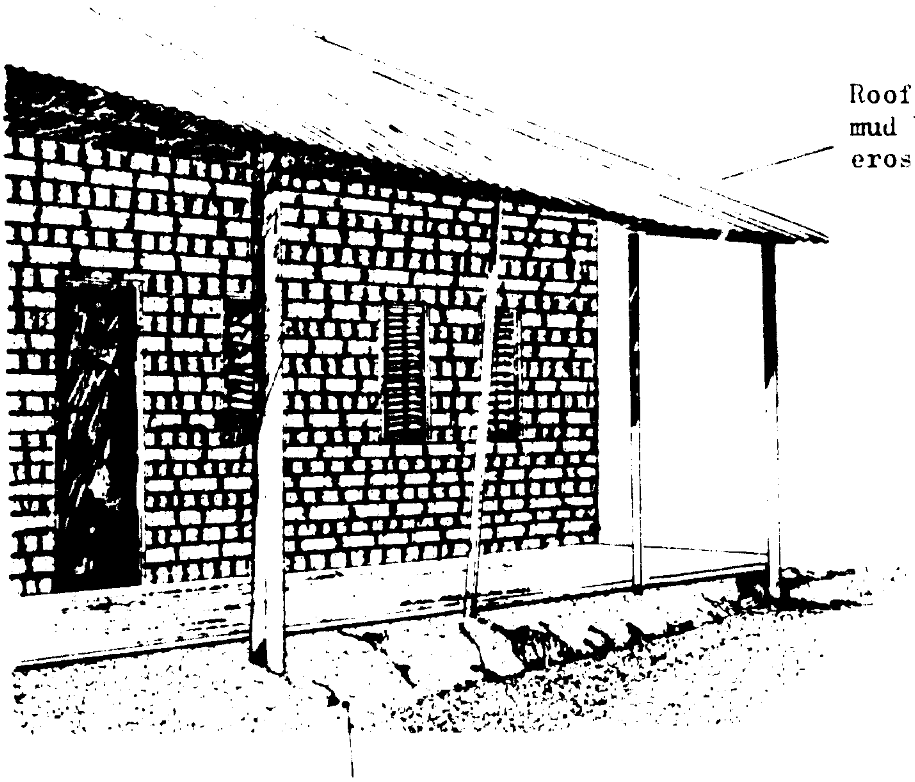
The approach to take therefore must be one which concentrates on the same sort of inputs that the traditional builder employs, but by modification to either the method of building or the processing of these materials, to find ways of making them durable where previously they would have been subject to decay.

Building Material Deterioration

Lord Keynes' famous remark that 'in the long term we are all dead' could be modified to apply to building materials - in the long term they all deteriorate. The description is relative, however, as some materials, such as hard-burnt brick, have shown themselves capable of lasting for centuries and will only presumably be worn down again to finer particles at the same rate as the weathering of granite. Other more contemporary materials such as glass, steel and plastic will also maintain their form for a very long time. For this reason the term 'permanent' though not strictly correct is usually applied to all this group of materials.

The building materials which deteriorate quickly are generally either organic in origin, i.e. vegetable and animal products, or mineral but in the form of soft stone or unconsolidated soil which can readily be disrupted by the wear and tear of human occupation, by biological attack or simply by heat, cold or moisture. Nevertheless, in suitably protected environments, ordinarily degradable substances such as wood and dried mud can also last almost indefinitely. Many historic buildings including some in tropical countries have significant parts of their fabric built of materials which in humbler structures would have rotted away after a few years. The wide differences in durability between the same material in several situations relates to the configuration and detailing in the building's design, or to the use of protective substances to prolong the life of the vulnerable components. Obviously in the second category the protective substances themselves must be durable. The buildings illustrated in Plate 3. on page 7 comprise some techniques used by traditional builders to try to prolong the life of structures. The problem eases considerably when it seen as one of obtaining durable surfaces rather than having to make the complete fabric of the building

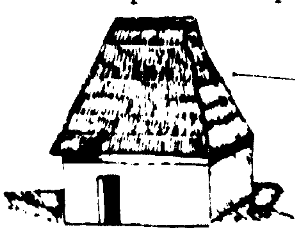
EFFORTS TO PROLONG THE LIFE OF UNSTABILISED OR DEGRADABLE MATERIALS BY THE USE OF SPECIAL BUILDING DETAILS



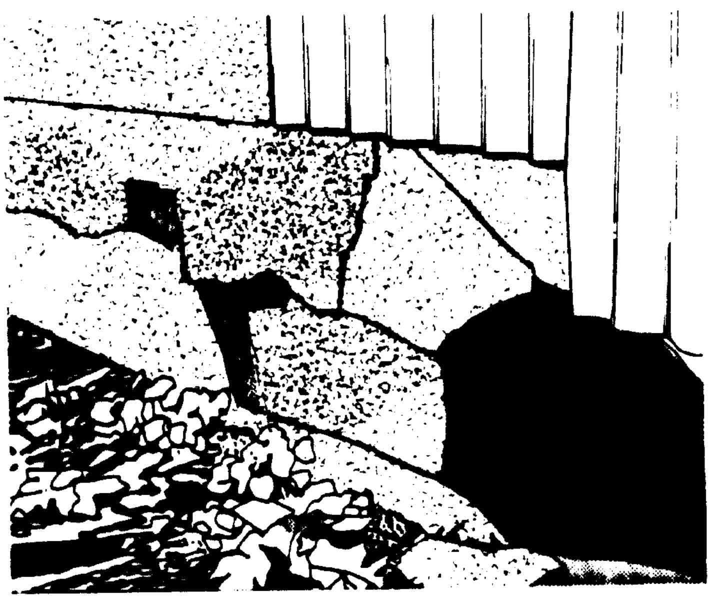
Roof overhang protects mud brick wall from erosion by rain

(Chief's house in Asokwa, Ghana)

Raised platform prevents ground water from entering building



Steep pitch used with some thatched roofs assists run off of rain, reducing waterlogging.



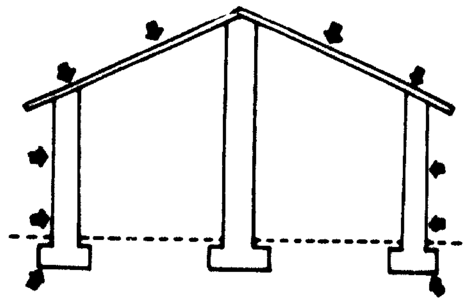
Protective cement renderings frequently tried, but are inclined to fall off. (Mud buildings in Tanzania and Southern Honduras.)

durable. Conventional building technology tends to 'over-engineer' parts of the structure particularly the upper sections of partition walls. These are often built of burnt brick or concrete, making them internally resistant to impacts, contact with water and biological attack even though they would normally never incur any of these.

A good starting point for consideration of appropriate technology in the building sector is to identify where high performance in the materials used is necessary and where it is not. The following summary is in a highly simplified form for the sake of clarity:-

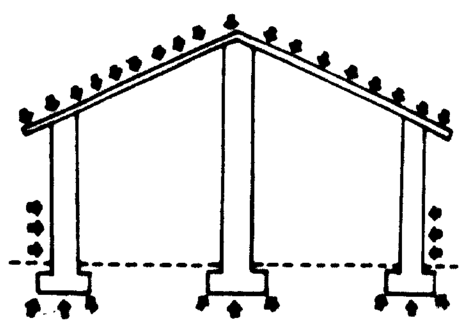
- For a complete building 'envelope' with secured openings, biological attack is usually confined to the external surfaces providing the building is kept reasonably clean and dry inside.

Biological attack



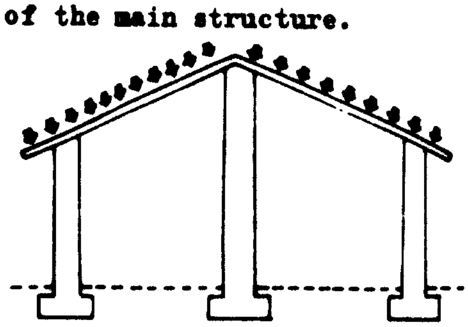
- For buildings equipped with a moderate roof overhang, in most climates contact with water will be confined to the roof, the lower part of the external walls and the foundations.

Contact with Moisture

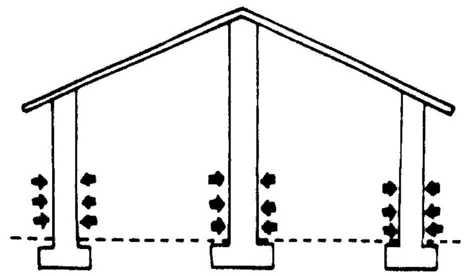


- Extremes of temperature change normally effect only the roof and those exposed walls which are not part of the main structure.

Temperature change effects



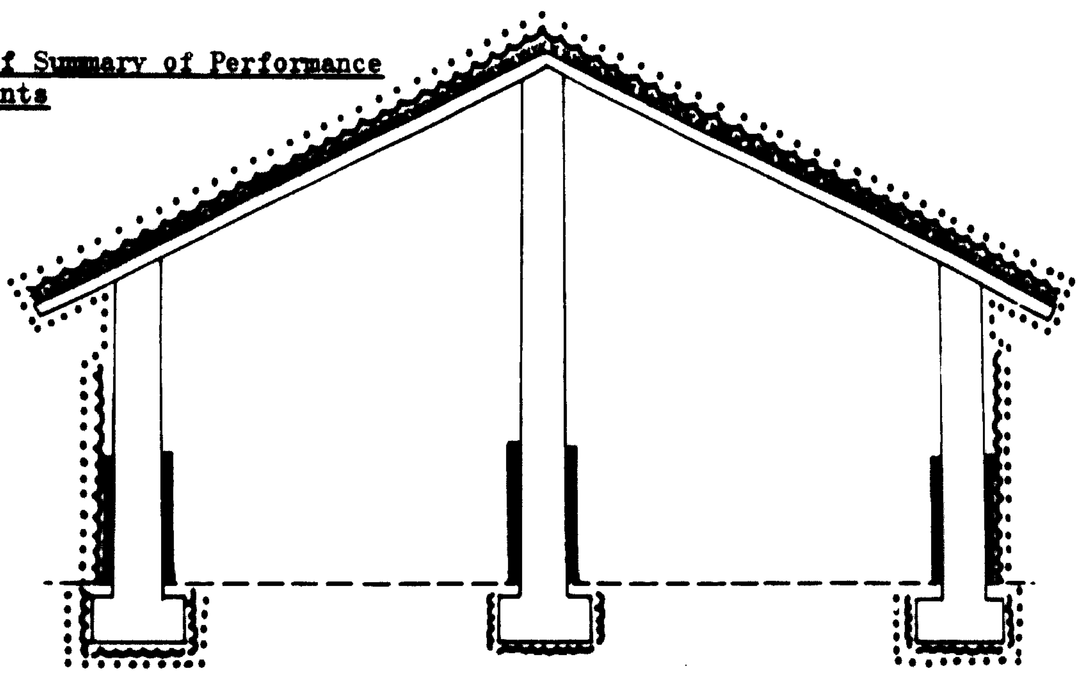
- In a single storey dwelling potentially damaging impacts are usually only incurred by the bottom $1\frac{1}{2}$ metres of the wall with the exception of the area of wall immediately adjacent to the door and frames or opening windows.



Potential areas of impact damage

From this type of analysis emerges a crude basis of a building prescription for communities with limited resources, but one which would seem tedious in the extreme to a conventional builder. The conventional builder is usually concerned more with saving labour than with the frugal use of materials. The minimum prescription would be based on the expected performance requirements of each bit of a building structure in order that economies can be made in the consumption of more expensive durable materials, so that they are only used where they need to be used.

<u>Diagram of Summary of Performance Requirements</u>



Special resistance properties required against:-

······Biological Attack
×××××××Wide Temperature Variations
〰〰〰Moisture Contact
▬▬▬Impact (Wear and tear associated with human habitation)

In exposed applications it is obviously advisable to use a masonry which is either fully stabilised or protected by a surface skin. The choice will depend on the relative cost or scarcity of materials which have to be purchased for cash - such as cement. Measures aimed to do without bought-in materials which are also heavy, become increasingly important the further away a building site is from the point of supply. This is a special restraint on Government building programmes and, as a result of the unacceptably high cost of construction using conventional standards in remote centres, public amenity buildings are frequently not put up at all, a factor which contributes to the deprivation of many rural areas.

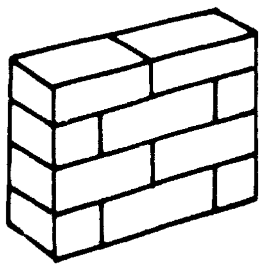
Appropriate technology methods can help to remedy this problem. The four examples of wall building techniques illustrated on the following page, (Plate 4.), indicate the approximate weights of purchased materials needed to achieve acceptable standards of durability in a square metre of masonry wall. In the examples shown, the quantity of cement consumed varies from 30kg to only 3kg. However, in two of the systems described, other materials have to be used in the effort to save the cement which would need to be used for conventional concrete blockwork. These include various fuels to provide heat in firing bricks or bitumenous additives to achieve stabilisation of soil bricks. Of the alternatives the most promising one for resource saving is the use of a strong protective plaster over unfired brick masonry - providing that correct techniques are used in formulating and applying the plaster, (unlike the examples illustrated in Plate 3. on Page 7.) In areas where indigenous fuel such as firewood is plentiful the best option is often to build in burnt clay brickwork laid with mud mortar and pointed with cement.

The processing of aggregates and soils to achieve a stabilised form often takes place away from the building site. This introduces an important division in the way the construction industry categorises its technologies - between the application techniques of building design and the manufacturing techniques for the production of building components. As will be outlined in the remainder of this paper, it is mainly in the manufacture of building materials that the most significant advances are being made in the development of appropiate technologies. Nevertheless, a correct understanding of the performance demands of different parts of a building will help limit areas of application of the more expensive materials and components, thereby reducing costs.

COMPARATIVE MATERIAL INPUTS REQUIRED TO STABILISE OR PROTECT SOIL OR AGGREGATE MASONRY

(Example: 1 square yard of 9" brickwork weighing 230 kg)

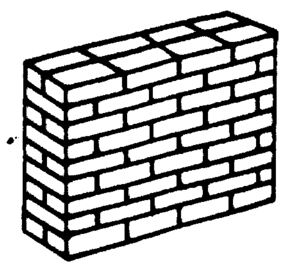
1. Sandcrete Blockwork



Solid blocks	Hollow blocks
30kg cement	20kg cement

(including sand/cement mortar joints)

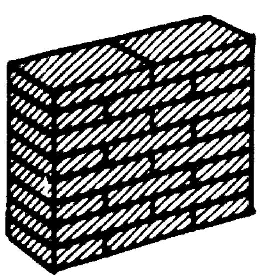
2. Burnt Clay Brickwork



Full sand/cement mortar joints containing 10kg cement	Clay joints pointed with cement mortar containing 3kg cement

Plus fuel to fire the bricks:
15kg gas oil (continuous kiln)
20kg coal (coal fired clamp)
40kg wood (wood fired clamp)

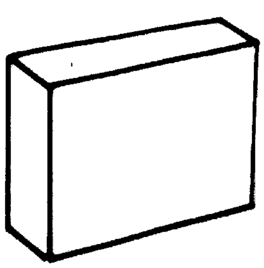
3. Asphalt or Bitumen Stabilised Soil Brickwork



Full sand/cement mortar joints containing 10kg cement

Plus stabilising additive for the brick
18kg bitumen or asphalt

4. Sundried Bricks laid in Mud Mortar coated with Protective Sealer and Plaster



3mm fibrous plaster skin contains 3kg cement

Plus 0.05kg fibre (natural or artificial)

Designing for Low Cost and Durability

It has already been established that the objectives of durability and reducing costs are in conflict. However, as outlined in the previous analysis, there are several parts of a conventional building structure where more expensive materials are used than are actually needed. For example, providing a building is equipped with a sound roof, much of the masonry in the internal walls and the upper and inner part of external walls need not be fully stabilised as protection against contact with water. Moreover, only part of the masonry needs to be impact resisting and protected against biological attack.

Accordingly, to reduce costs it should be possible to change the nature of the wall above the 5ft level and perhaps to use unfired brick which could be less than half the cost of burnt brick and concrete block. Moreover, it should be possible to make even unfired brick walls reasonably impact resistant by applying a suitable fibrous plaster, providing that it is properly adhered to the surface of the unfired brick. As a result of this type of thinking it is possible to conclude that a durable building could be made with only the lower 5ft of the external wall constructed out of conventional masonry. It would only be possible to go further than this if there were sufficient roof overhang to protect the whole of the wall from rainwater contact or alternatively, if a protective plaster which could ensure both impact resistance and water resistance, (and incidentally, prevent biological attack), could be applied.

Obviously the critical item in all these specification decisions is the security of the roof cladding. The task of erecting a sound roof is the constant predicament for poorer rural communities. Many alternative systems are in common use but none is able to solve the problem of obtaining durability at a low cost.

Thatch - There is a double health hazard in the use of thatch. It provides a perfect shelter and breeding place, not only for vermin; rats, mice, etc., but also for the various bloodsucking vectors of such diseases as tripanosomiasis.

Corrugated iron sheets - This material requires sophisticated manufacturing processes for the sheet steel and galvanizing process and is generally an imported item for ldcs. As imports they are costly, but in spite of this are a far from satisfactory roofing material. In countries where there are wide differences between day and night, summer and winter temperatures, corrugated roofs, being poor insulators, do nothing to mitigate the discomfort caused by temperature variations.

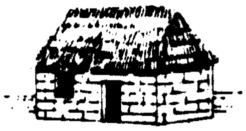
Tiling - A minority amongst ldcs have traditional tiling industries which meet the roofing needs of a significant part of the population. However, there are several disadvantages to this type of roof. In countries where sawn timber is scarce, use of tiles adds to the problem because of the complexity of the roof structure required. Elsewhere, in earthquake zones such as Central America, tiled roofs can be a major cause of loss of life because of the inadequacy of the walls and timber structure.

Asbestos cement roofing - This material shares an advantage associated with tiling, being a far better insulator than corrugated iron. As a result it is popular and this popularity is enhanced by the sheets' requirement for a relatively small amount of supporting timber structure. On the debit side the sheets have the disadvantage of being brittle and subject to handling and transport damage on the rough roads in rural areas. The manufacturing process is essentially large scale and unsuitable for village production. As rainwater collection

THE ROOFING PREDICAMENT FOR POORER COMMUNITIES - SUMMARY

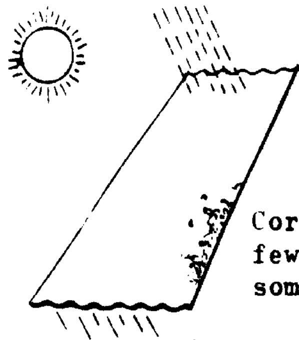
SEVERAL ALTERNATIVE SYSTEMS ARE IN COMMON USE BUT EACH HAS ONE OR MORE SERIOUS DRAWBACKS

TRADITIONAL THATCHED ROOFS OFTEN LOOK BEAUTIFUL BUT ARE UNHEALTHY AND NON DURABLE



- Quickly become infested 
- Begin to leak after a few years 
- Easily catch fire 

CORRUGATED IRON SHEETS



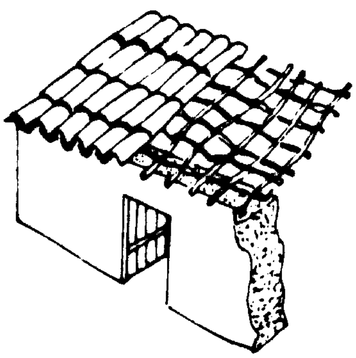
Are noisy when it rains

Corrode after a few years in some areas

Transmit the sun's radiation into the house

Often require the extra expense of installing ceilings

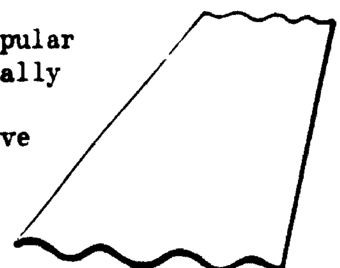
SPANISH TILES ARE POTENTIALLY LETHAL ON AN UNSOUND ROOF STRUCTURE



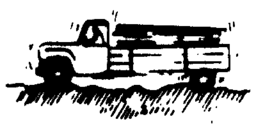
Many rural houses have incredibly ramshackle roof frames on equally insubstantial walls . A serious hazard in earthquake or hurricane areas.

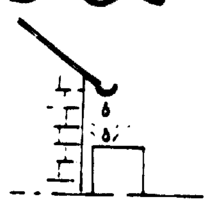
ASBESTOS - CEMENT SHEETS

Very popular but usually too expensive



Often arrive damaged after rough rides





May be unsuitable for rainwater collection because of health risk with asbestos dust.

off roofs is becoming increasingly important for tropical communities, another question is raised about the suitability of asbestos cement roofing. The dust produced by the sheets after installation is now being regarded as a health hazard and for this reason it is possibly inadvisable to use water containing this dust for domestic consumption.

Special Problems of Rural Areas

Peoples' difficulty in raising finance for vital materials to extend the life of their dwellings is most conspicuous in the appearance of shanty settlements on the fringes of many ldc urban centres. The problems of the rural areas are even greater. Because of the dreadful condition of rural roads, as illustrated in Plate 5., the costs of materials such as cement or roof sheets are frequently three times as much as the price paid by urban dwellers. Rural housing usually looks far more workmanlike than most urban shanty town dwellings but this is largely due to the well learnt lesson of the value of maintenance and to the consistency of style and materials used. Also the rural householder has greater security of tenure than his urban fringe counterpart, as mentioned earlier, and so is prepared to take more pride in his dwelling.

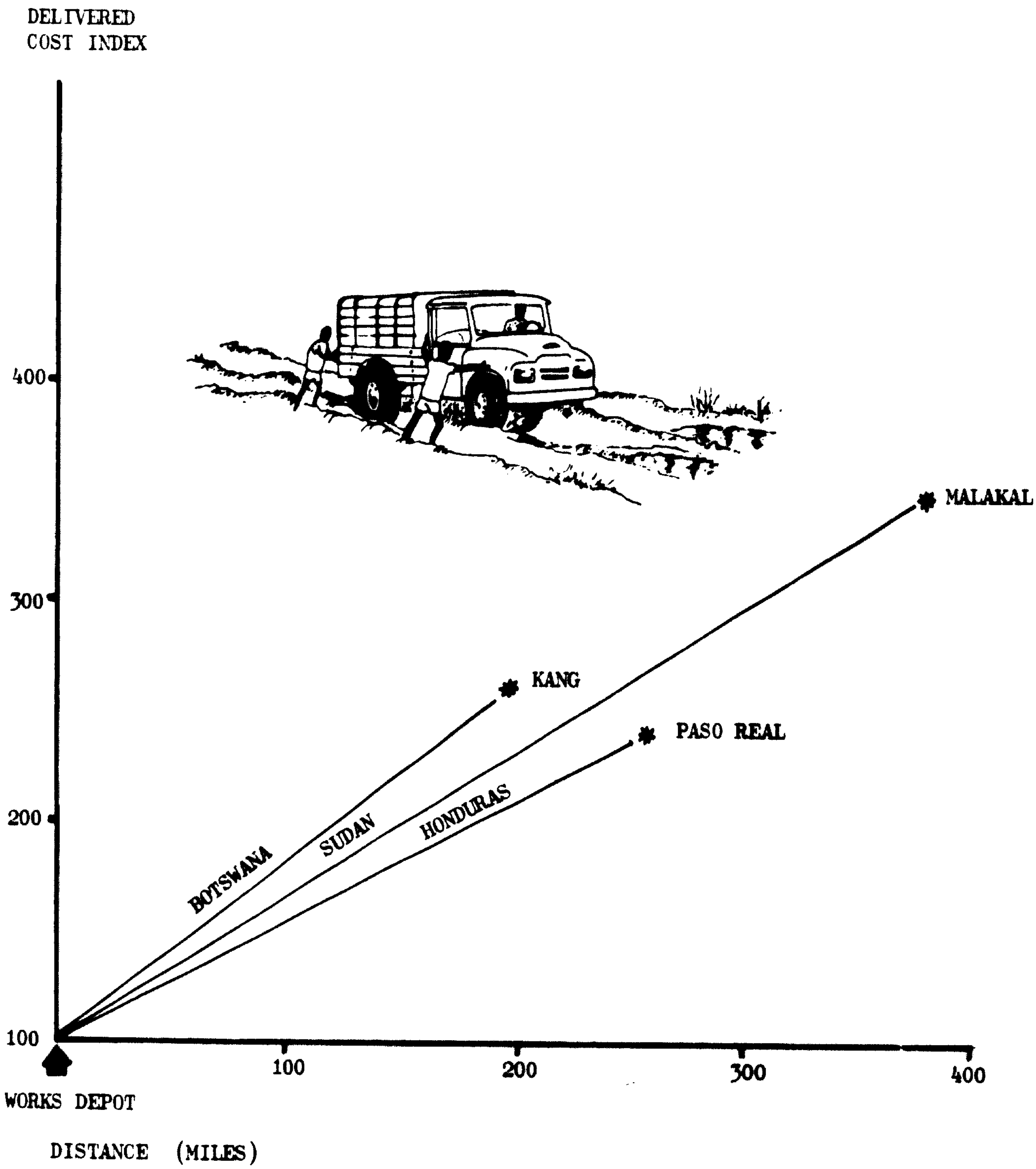
The frequently smart appearance of traditional dwellings nevertheless conceals a host of problems:-

- decay and eventually dereliction frequently in as little as 5 years and the need for continual maintenance in the meantime

- increasing infestation by disease carrying vermin

- loss of much of the originally purchased material when the dwelling is finally abandoned.

EXAMPLES OF THE EFFECT OF TRANSPORT DISTANCE TO REMOTE RURAL AREAS ON DELIVERED PRICE OF CEMENT



Notes:

Based on delivered cement price compared with prices at Works or Depot at Kosti, Sudan: Lobatse (ex Mafeking), Botswana: San Pedro Sula, Honduras.

In these examples transport costs exceed the ex depot price of cement after about 100 miles over poor roads.

There is a scarcity of paid employment in rural areas, a factor which combined with the relatively higher costs of conventional materials, makes it considerably more difficult for rural people to upgrade their buildings by the use of protective and preserving substances.

Appropriate Location of Production Facilities

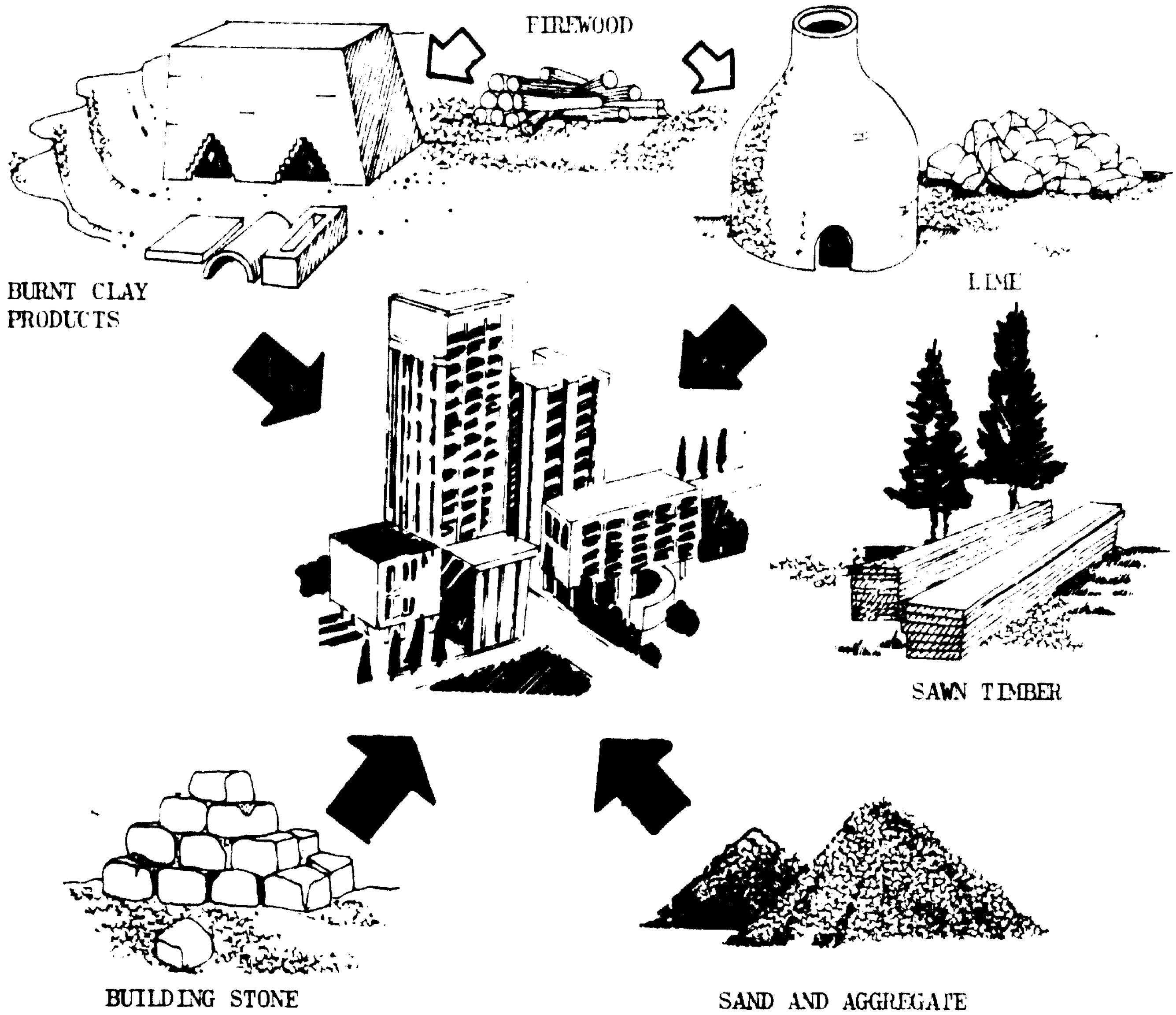
While the rural areas are the ones which suffer greatest deprivation in the use of adequate building materials and components, the logical position seems to be the opposite. The rural areas, being the source of origin of most materials used in building as illustrated in Plate 7. on page 18, should obviously be the location for much of the production plants. Why, for instance, bring the process materials for brickmaking; clay, sand, firewood, water, etc., into the town to make bricks if all these resources are available in the nearby rural area? It is more logical to bring in the finished product which, for instance, is only half the weight of the sum of the process materials used in the course of manufacture. Furthermore, there is a strong commercial argument against quarrying in the near vicinity of urban areas if the end result is a loss of land area for building. Many urban fringe brick industries such as those of Egypt and the Sudan have their clay workings on river banks and actually consume land as they in effect widen the river. At a later time the land area previously consumed would be worth, for building, many times the value of the bricks originally produced.

If instead, bricks and other building materials were to be made further away from the town, the economic and social benefits would be multiple:-

1) Employment would be generated outside the city, providing a counter attraction to the strong desire by rural peoples to move to the city in search of paid jobs to generate cash to buy clothes, medicines and consumer goods.

2) Any land consumed by the manufacturing process would be of marginal value compared with urban or future urban land.

ECONOMIC ROLE FOR RURAL AREAS AS LOCATION FOR BUILDING MATERIALS MANUFACTURING PLANTS



Villages which are within reasonable delivery range of an urban market should be made the location of building material manufacturing enterprises - established on an appropriately small scale.

Elsewhere, cottage industry units should be encouraged for the more remote villages to at least provide for some of their own needs.

3) In many manufacturing processes, bulky or heavy materials such as water and firewood can be consumed on the spot without adding to the cost of transport into the urban market area.

4) Additionally, the 'waste' grades of damaged or imperfectly processed materials which might be burnt or dumped by an urban plant would be rapidly gleaned and put to some use in a rural environment. For example, pieces of tiles or bricks cracked or broken in the course of manufacture are soon carried off for use in building bread ovens or house walls in the village.

However, many of the world's poorer communities live in areas which are so remote from any prospective urban market that much of the above argument does not apply, here the emphasis alters and concentrates on self-sufficiency instead. These are the people who have the least chance of building permanently as they will tend to have the least prospect of earning cash to buy materials and the conventional products such as cement, which by the time they reach the village will cost far more than in the city.

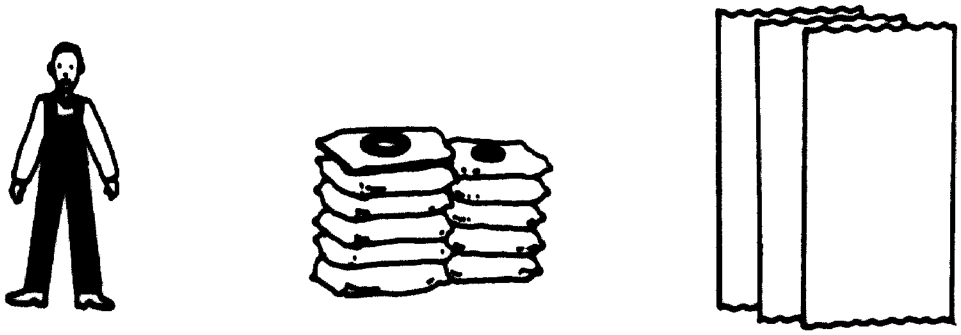
The people in remote areas quite frequently obtain some form of paid employment although this is often seasonal, associated with the requirements of estates or ranches. Faced with the wish to purchase such basic building items as cement and roof sheets, as illustrated in Plate 8, a rural builder may be ten times worse off than his compatriot in paid employment in the city (and incidentally a hundred times worse off than a working man in most western industrialised countries). The position is not quite as bad as it seems, however, as the urban dwellers have most of their larger incomes already spoken for in food, rent, the clothes necessary to perform the work and the cost of travelling to and from home. The rural dweller caters for most of his basic subsistence needs and intermittent windfalls of cash earning are mainly at his discretion in its disposal.

Roofing Products

Returning to the argument that greater durability in dwellings could play

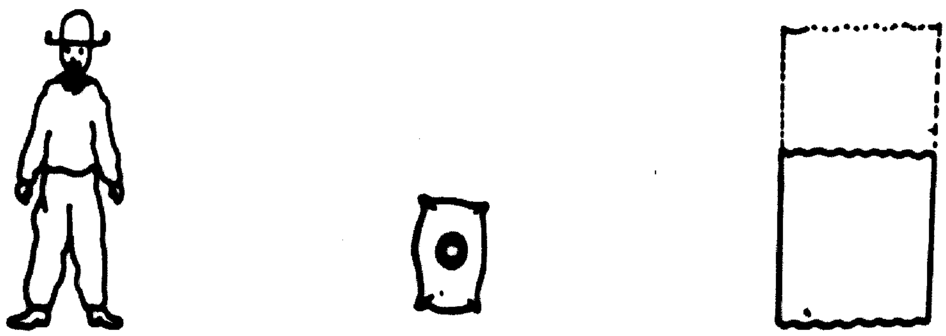
RELATIVE ECONOMICS OF LABOUR, CEMENT AND ROOF SHEETS, 1978

NORTHERN EUROPE



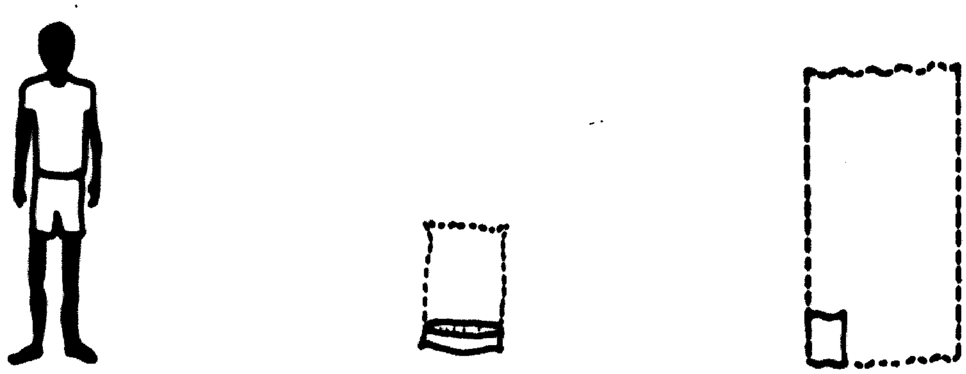
1 DAYS WAGES = 10 BAGS OF CEMENT = 3 ROOF SHEETS

CENTRAL AMERICA (URBAN)



1 DAYS WAGES = 1 BAG OF CEMENT = ½ ROOF SHEET

EAST AFRICA (RURAL)

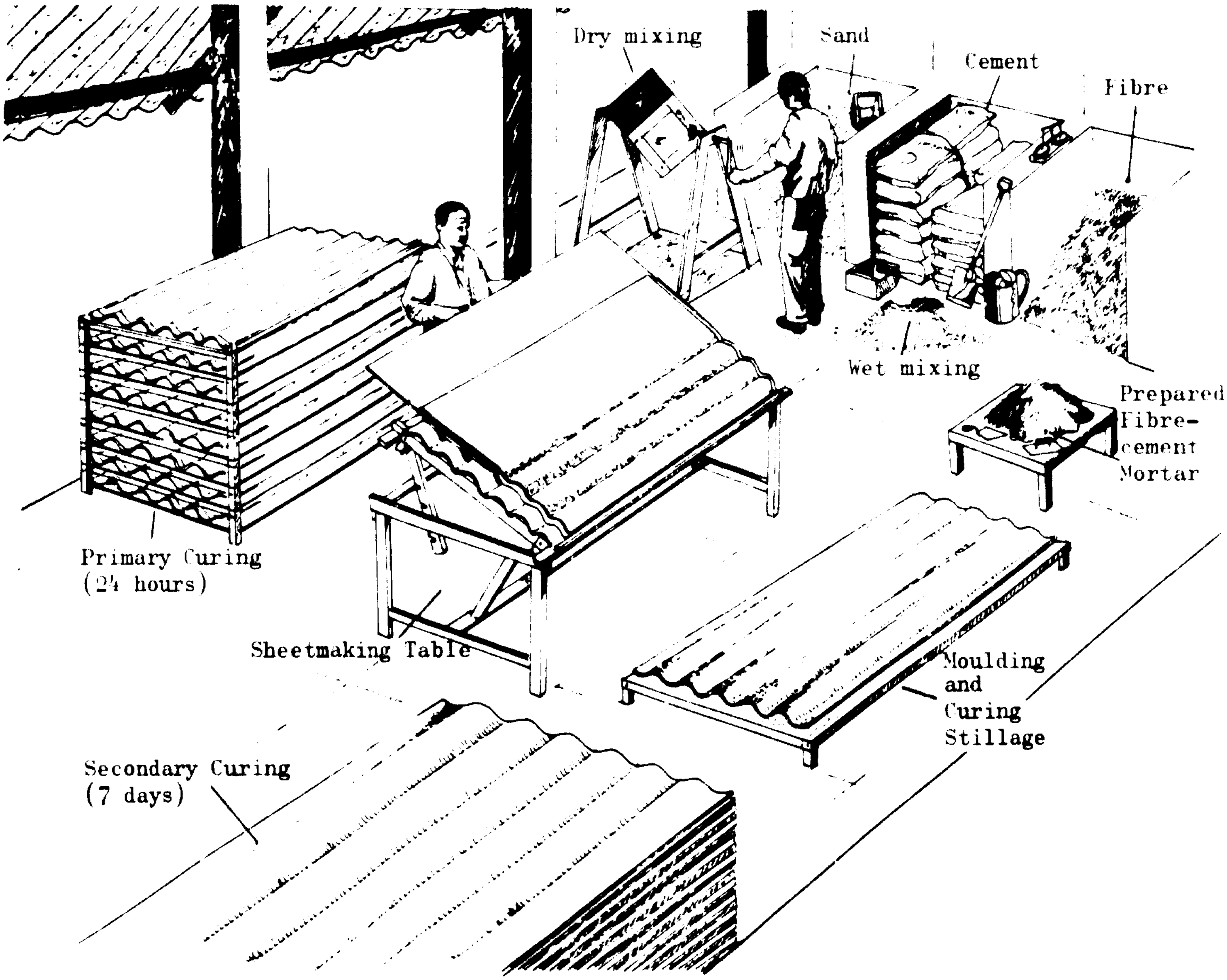


1 DAYS WAGES = 1/10th BAG OF CEMENT = 1/24th ROOF SHEET

a key part in breaking into the rural poverty cycle, it would be desirable if the labour spent in construction could be turned into a form of savings, a dwelling that increases its value with the passing of time. Most important of all is the provision of a roof which lasts beyond the brief life cycle of the traditional thatch and in the process protects and prolongs the life of all the other materials within the dwelling. The only example of a locally manufactured roofing product which begins to meet the essential criteria of being durable itself and able to keep the inside of dwelling dry, is the clay tile. Indigenous styles of tiling in significant use include Mangalore tiles in India and Spanish tiles in Central and South America and some parts of Africa. The latter and other handmade products tend to be heavy and accordingly demand complex and timber-consuming roof structures. As a result, the indigenous clay tiling technology has only prospered in areas where timber has remained plentiful and cheap. The countries where timber has increased in relative scarcity and cost have tended to abandon the use of tiles in low cost construction. The lighter weight machine-made tiles are generally unsuitable for manufacture in village plants because of the capital required in setting up.

If the use of a tile product which is made with totally indigenous resources of materials and labour is impossible because of the cost of timber, the obvious substitution is by sheet materials which demand far less in supporting structure. Moreover, tiles are generally too heavy to be used in constructing wide overhanging roofs to protect the walls. However, far from being a product suiting village manufacture, hitherto corrugated roofing sheets have been made in mechanically sophisticated factories and for most ldcs are an imported product. In the case of galvanised corrugated iron or other metal sheets, this will continue to be the case. On the other hand, there are greater prospects of other types of sheets. made using a combination of fibres and a strong binder, being produced on a small scale. Work is advanced in development of asphaltic materials to bind together a fibrous mat for production of sheets. However, up until now, at least two of the production stages have required the use of machinery and would rule the process out for most village or self-help applications. Nevertheless, the use of cement as the binder is leading to a more promising technology. It is technically feasible to make a full size roofing sheet entirely by hand using cement, sand and fibre, using a simple process illustrated in Plate 9.

ILLUSTRATION OF A PROCESS IN ADVANCED STAGE OF DEVELOPMENT FOR MANUFACTURE OF FULL SIZED CORRUGATED ROOFING SHEETS USING CEMENT, REINFORCED WITH ARTIFICIAL OR NATURAL FIBRES (I.T. BUILDING MATERIALS WORKSHOP, U.K.)



Pilot plants now in operation in the U.K. and Botswana with capacity for producing 6 - 10 sheets a day employing 2 men. For 8ft. fibre-cement sheets in low labour cost economies using local natural fibres, production costs are estimated at under US $4.00 a sheet, approximately half the cost of conventionally manufactured equivalents. If a local natural fibre is used, the bought material cost will consist of cash paid for cement only, and this could be as little as one sixth of the cost of buying ready-made sheets. Roof sheets are an imported product for most ldcs and so the development could lead to considerable import savings as well as reduction of building costs.

The previous discussion outlined how inordinately expensive a bag of cement must seem to a builder in rural areas of many ldcs. In the example given it takes 10 days work to earn enough money to buy one bag. However, the prospects for purchasing roofing sheets are even worse; 24 days wages to buy a single sheet. Nevertheless, many people save enough money to gradually roof their houses with sheets - a process which sometimes takes several years by which time the part of the structure roofed with less satisfactory materials may have already begun to deteriorate. In contrast the manual method of manufacturing fibre-cement roofing sheets which is in an advanced stage of development, uses about 20kg of cement to make a $2\frac{1}{2}$ metre or 8ft long corrugated sheet. 20kg of cement represents 4 days wages for the rural worker in the example compared with the 24 days wages he would need to spend to purchase a ready made sheet. The difference in expenditure of cash is 6 to 1 and so the installation of a handmade roof sheet production unit in a village could make a profound difference to the prospect of people being able to roof their own houses with sheets in the near rather than the distant future.

The key to the sheetmaking technology is the fibre. The most straightforward fibres to use are the artificial ones such as alkali-resistant glass or polypropylene but the purchase of artificial fibres would eat into the economic benefit of local sheet manufacture as the fibre might cost nearly as much as the cement. Fortunately a number of natural fibres show promise as cement reinforcing materials. These include human and animal hairs, various grasses and most of the wide range of natural fibres used for the manufacture of ropes, mats and sacking. If fibre from the local area of the village can be used in the sheetmaking, the relative cost would make the handmade roof sheet system extremely commercially attractive to install. How government or international agencies might go about introducing new appropriate technologies of this type will be considered in the final paragraphs of this paper.

Viable Labour Intensive Manufacturing - the Brick Industry

In all the serious study of appropriate technology industrialisation in ldcs, many researchers have failed to note the significance of the one repeating example of an active, independent and self-sustaining manufacturing industry - that of making bricks, in a great variety of poorer and middle income countries. It is ironic, that where government has intervened, and encouraged the introduction of advanced technology, capital intensive brickmaking plants, the ventures have frequently resulted in failure.

It is of significance both in this discussion of building materials and also in a wider context to dwell for a little on the essential differences which have led to the survival of traditional brickmaking while so many modern plants have failed.

Productivity of Labour and Capital in Brickmaking

In contemporary burnt clay brick plants serving the building trade in Europe and America the manufacturing technology has gradually evolved towards ever higher labour productivity and use of large scale energy consuming machinery. The only change in established trends of late has been a return to slightly smaller scale plants which are now turning out to be more economic from the standpoint of market distribution costs and ease of administrative control.

Analysis of the reasons behind the greater degree of mechanisation in the most modern plants shows up factors which are not necessarily present in many ldc.s.

1) Fear of labour scarcity in the years up to the general economic recession following the OPEC oil price rises of 1973 led to the specification of extremely expensive equipment such as 'setting' and 'dehacking' machines which substituted for manual jobs but which could not really be justified on the basis of wage cost savings alone, even at industrialised country levels.

2) Brick manufacturers have also been influenced towards eliminating as much labour as possible in the design of new plants because stricter employment legislation in many countries makes it increasingly difficult to lay off labour. This causes problems for an industry supplying an essentially very cyclical market - the building trade.

3) Swing of the brick industry to manufacturing greater proportions of facing bricks with special aspects of colour and texture caused the introduction of machines which could precisely control these aspects but which would not be needed for the production of common bricks for normal masonry work.

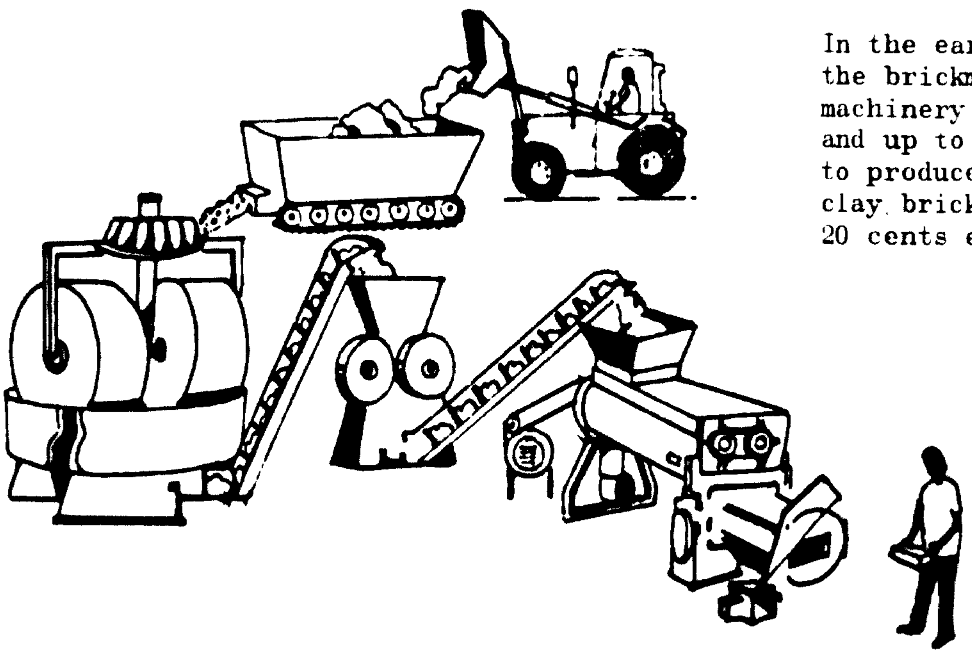
4) Introduction of new fuels such as natural gas and propane produced changes in kiln and dryer design to take full advantage of these new fuels.

When highly mechanised brick production plants are introduced into low labour cost economies the inappropriateness of the technology becomes immediately apparent even before the bricks go to the most capital intensive unit of all, the kiln. In the process stages leading up to the shaping of the brick out of wet clay, conventional modern technology plants can turn vast outputs of bricks - up to 20,000 in an hour with as few as 6 men employed. To make a virtually identical product by handmoulding, the same six men would be doing well to make 200 bricks. However, such is the cost of running the heavy machine line, the enormously higher productivity only outweighs the capital, energy and maintenance costs if the labour replaced would have been earning over $3.00 a day.

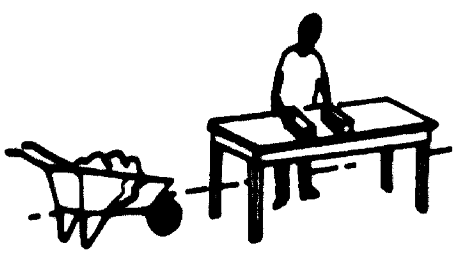
When the rest of the brickmaking process is taken into account, the productivity difference between the conventional/mechanised and the traditional brick plant is less wide so that in total the productivity of the former is probably only 50 times higher than the latter. Fifty times greater labour productivity would of course be attractive to any entrepreneur contemplating setting up a brickmaking factory if labour were the only cost. Unfortunately, to achieve this sort of productivity involves expenditure of 4 or 5 million dollars which places a heavy financing cost on every brick produced. Far heavier in fact than the wages cost of the workers who would have been employed if a labour intensive plant were built instead, as is illustrated in Plate 10.

Further to this argument, much of the processing of the raw material to feed a modern extrusion plant is not necessary for the type of brick

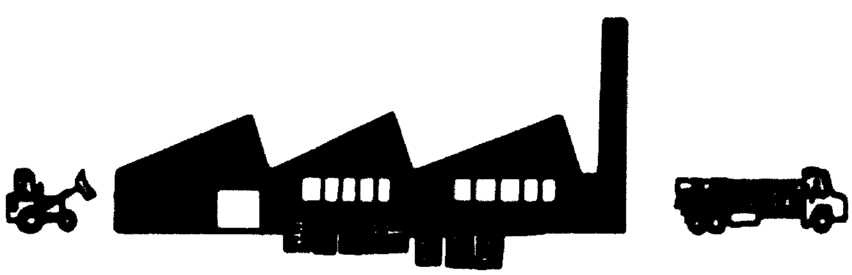
PRODUCTIVITY OF LABOUR AND CAPITAL IN BRICKMAKING



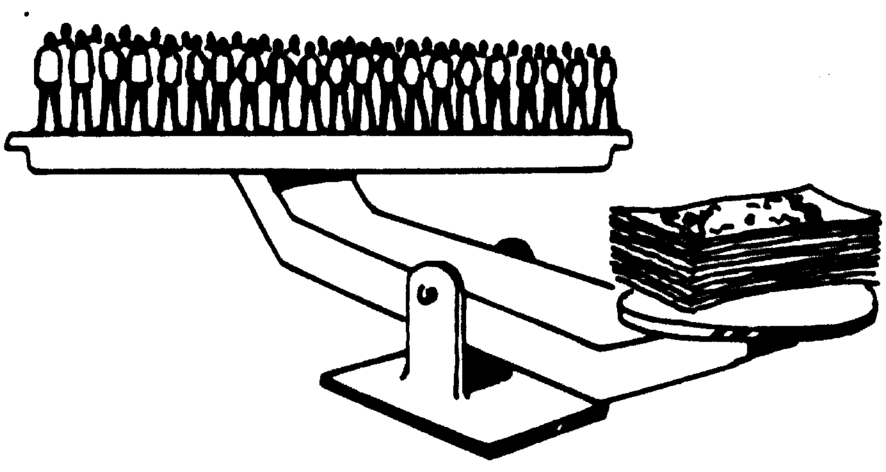
In the early stages of the brickmaking process machinery costing $½ million and up to 500 h.p. are needed to produce unfired clay bricks for about 20 cents each in total cost.



Virtually the same product can be made manually for the same cost, in countries with labour wages below $3.00 a day.



Labour used in large scale advanced technology brick plants often 50 times more productive than in traditional plants -



But in a low labour cost country the financing costs for the plant alone usually exceed all the wages saved in extra productivity.

product needed in most ldc building applications - but the 20,000 brick an hour extruder cannot operate with less well-prepared raw material so the work has to be done anyway.

Fixed and Variable Costs

The most significant reason behind many of the failures of mechanised brickmaking plants in ldcs while the traditional producers kept going unaided, is probably the make up of the total cost structure.

The feature of an advanced technology brick plant is that the majority of its costs are incurred just the same even at times when output varies. In other words the factories have a high element of fixed costs and even some of the variable costs such as the skilled labour controlling kilns, are in effect fixed unless the plant actually closes down.

High fixed cost plants are extremely vulnerable if the market for the products fluctuates, as construction markets tend to do. What seems to have happened in a number of instances with heavily mechanised brick plants in ldcs was probably never even mentioned in the feasibility studies before they were set up; i.e. what happens in times when the plant cannot sell all its output?

Nearly all the advanced technology brick plants in both ldcs and western countries are based on single kilns or two kilns. These units are designed to run at a set output and so there is little flexibility in production levels. Indeed the high fixed cost component makes it essential to run at maximum output to keep unit costs down. However, in periods of low market demand, which could be caused by political upheaval or a transport fuel shortage or simply an economic recession, the brick plant has to go on producing up to 100,000 bricks a day. Each unsold days production occupies 50 square yards of storage space which in times of severe recession has to be extended at a considerable capital cost while all the time operating costs also rise in the extra forktruck distances involved as the stocks extend.

What happens next is an attempt by management faced with cash flow difficulties to economise on operating costs. The only significant ones which are not fixed are those associated with production and maintenance labour, and maintenance material and components. Almost inevitably such economies begin to affect the plant's ability to sustain its designed output. When output falls, fixed unit costs begin to rise which in the case of the heavy capital plants usually results in overall unit costs going up in spite of the economies in variable costs.

Faced with higher total unit costs, management then feels obliged to try to recoup part of these from the market by raising prices. However, a building recession is the wrong time to raise prices and customers tend to turn to alternative materials or revert to using the products of the traditional producers. It is when sales of the mechanised plant begin to fall at this stage that the real crisis begins. Stocks get out of hand and management is forced to reduce output by shutting down one kiln if two were installed or, if only one, running it at half speed which means that nearly as much fuel is still used but for a reduced quantity of bricks.

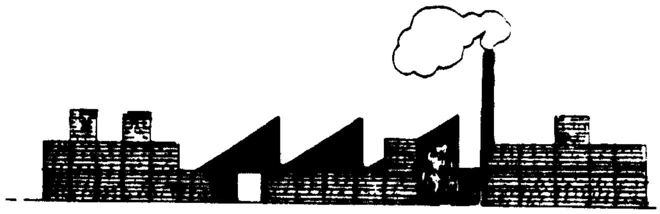
A heavy capital brick plant running at half the designed output frequently incurs total unit costs 70-80% higher than when run at normal output. Privately operated units generally close down after operating for a time under these conditions. Whether or not public money was involved in the original investment, state takeover may follow but whatever public corporation is involved, it rarely stands much chance of putting the factory back on its feet. This is because during the running down period essential staff will often have been lost, extensive damage done as a result of forced economies on essential maintenance and so on.

The traditional plants during this time will have no doubt suffered equally from falling demand but their reaction will have been entirely different which accounts for their resilience. A most notable feature is common to the traditional brickmaking industries which exist across the world in, to name just a few examples:- Malawi, Sudan, India, Indonesia, Honduras, Mexico, Turkey, Egypt and Lesotho. This feature is that the brick plant owners do not expect to keep going at the same constant output. In fact the brickmakers in most of these countries mentioned operate only seasonally anyway and stop production during the rainy season. A comparison between how a mechanised and a traditional style brick plant may cope or fail to cope with a slump in demand for their products is described in Plates 11. and 12.

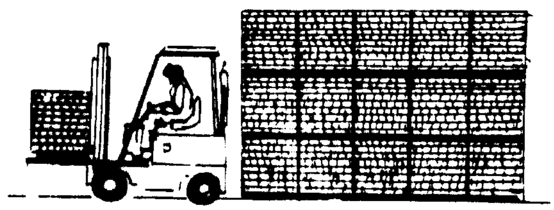
IMPLICATIONS OF LABOUR-CAPITAL RATIO IN BRICKMAKING

. IN LARGE MECHANISED PLANTS ANY MARKET DIFFICULTIES IMPOSE HEAVY PENALTIES

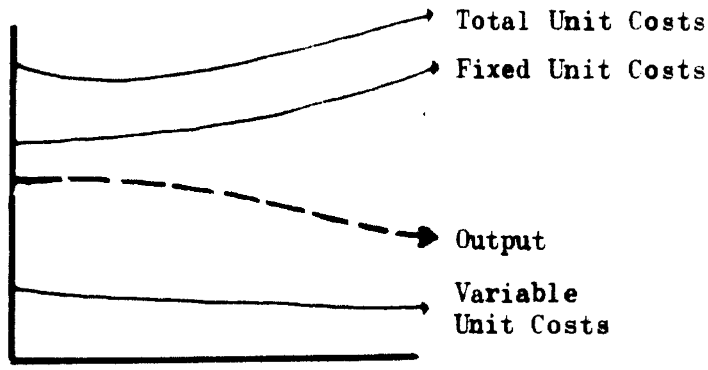
In a period of slow sales, the plant is quickly surrounded by large volumes of unsold bricks. Production has to be kept to a maximum because of high fixed costs.



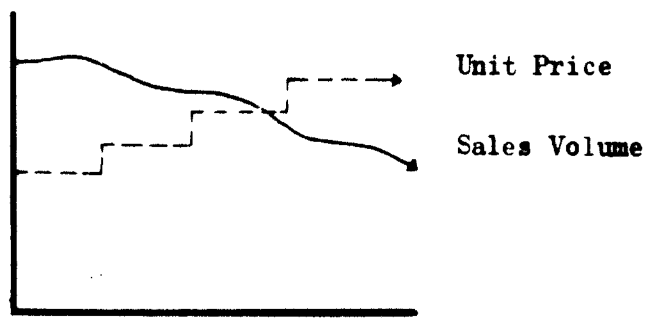
Large inventories increase the running costs by increasing trucking distances within the plant site and demanding additional paved areas for the extra packs of bricks. Losses and wastage also increase at the same time.



Higher costs produce the need to make economies to save cash flow. Economies are often made in variable cost items such as maintenance and production labour causing output to suffer. This often increases fixed unit costs to a larger extent than variable costs have fallen. The eventual result from the attempted economies is therefore that total unit costs actually <u>rise</u> although cash flow improves.



The still higher unit costs force the plant operators to increase their prices to prevent losses being incurred. As prices increase, sales may fall further due to the price mechanism.



As a result of further loss of sales volume, the inventory situation gets out of control until a cutback in production is forced on the management, and unit costs then rise to the point that the plant becomes totally uneconomic, - at which point it is usually taken over by a government corporation!

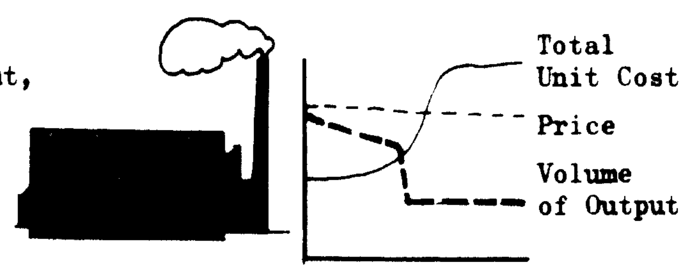
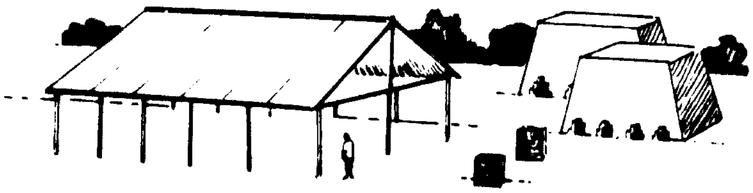


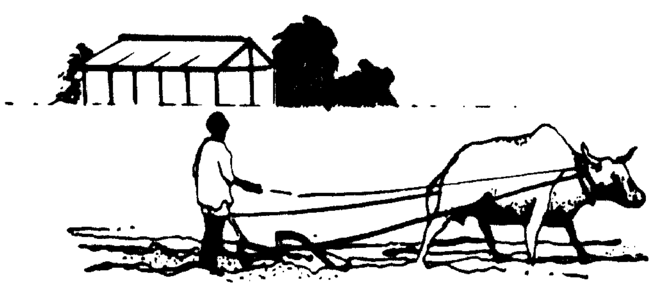
PLATE 12.

IMPLICATIONS OF LABOUR-CAPITAL RATIO IN BRICKMAKING

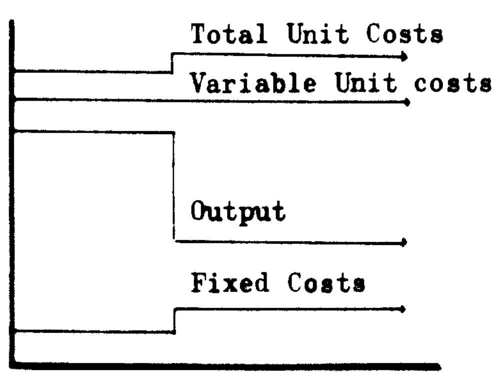
2. LOW CAPITAL INVESTMENT, SMALL SCALE BRICK PLANTS HAVE FLEXIBILITY TO COPE WITH TEMPORARY FLUCTUATIONS IN DEMAND OR RESOURCE AVAILABILITY



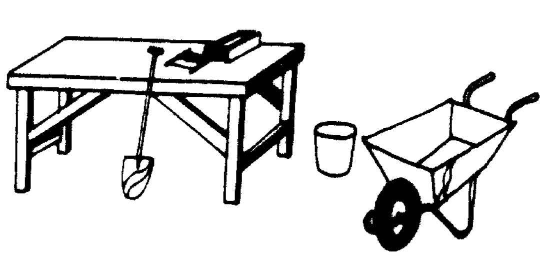
When market demand slows down, stockbuilding is confined to completed clamps of bricks which can be left to stand burnt or unburnt without additional cost.
Labour is a fully variable cost and workers may be laid off except for watchmen when no income is available to pay wages.



Brick plants can also cope with periodic labour shortages, for instance during planting seasons, by reducing output until the workforce is available again.



Because variable costs make up the majority of all costs, when output is reduced unit costs only rise slightly. Fixed unit costs increase in proportion to the cut in output but they only make up a small element of total unit costs and the effect is not serious.



Simple, small scale equipment can stand idle for a few weeks or months without significantly altering longer term economic viability. Production levels can be altered in small increments by varying the number of workpeople.

Having very little in the way of fixed costs to worry about they only restart making bricks if they feel fairly sure there will be a market. Such a policy does not work to the benefit of the building trade which in many countries puts up with a period of severe brick shortage while waiting for the traditional producers to make up their minds that the rains have stopped and it is safe to make bricks again.

The essence of the resilience of the traditional brickmakers and their survival when normal commercial undertakings would have gone to the wall, can be summarised as follows:-

- While most mechanised units are utterly dependent on supplies of energy and spare parts, all usually imported, many traditional brickmakers can keep themselves going, obtaining their own supplies of firewood for fuel, and making and refurbishing most of their own simple production tools.

- Stockpiles of finished bricks do not need to be expensively managed and provided with extra facilities. Instead, the inventory could just consist of fired clamps of 40,000 or so bricks, left to stand without further attention until the market requires them. It is even possible to stop outflow of cash before a clamp is fired, by leaving it with the bricks still in the dry form, sheeted down for protection against rain.

- Even though labour laid off from a traditional plant will suffer hardship during times of low market demand, they do not usually expect or completely depend on the employment and can drift into other work until things improve. This is certainly preferable to the brickmaking operation going out of business completely.

- During a time of crisis and prolonged market stagnation, if all else fails the traditional brickmaking undertaking can simply disappear and lie dormant. The only indispensible commodities needing to be preserved intact are the technical knowhow and management ability of the individuals concerned, which can be applied to bring about the reappearance of brickmaking when conditions again become favourable, unlike the mechanised plants, which being dependent on imported resources, frequently become inoperable.

The most commendable feature of the traditional brickmaking industries therefore, is that they usually survive. Only in occasional instances have general market conditions or the arrival of mechanised brick production eliminated the traditional operator. Where this has happened the culprit has usually been the sandcrete block which is easier to make and quicker to build with and in the past was often cheaper, prior to the effect of the Energy Crisis on the price of cement. Since the time of the big rises in the cement price there has been a notable revival in some traditional brick industries and attempts to establish new industries by many ldcs where brickmaking has died out in the past, or never existed at all.

Gaps in Technology of Brickmaking and Other Building Materials Manufacture

In contrast with the desirable features of the traditional brick trade there are a number of unsatisfactory aspects which amount to gaps which might be filled by officially sponsored research and development programmes. It is notable that the traditional brick and tile producers have operated for decades virtually without any R and D and little or no help from outside. Care will need to be taken that in encouraging the introduction of improved methods, the vital survival ability of the traditional production units is not lost.

An examination of priorities for research and development was recently commissioned by the Overseas Division of the U.K. Building Research Establishment. The conclusions reached were that in most places where it was technically possible to make bricks and a worthwhile market for them existed, bricks of a kind were usually being produced already. The prevailing need appeared not so much to create technologies which would enable people to make bricks who were previously unable to do so, but more to help existing producers make better quality bricks more efficiently, less impeded by climatic changes and in more congenial conditions.

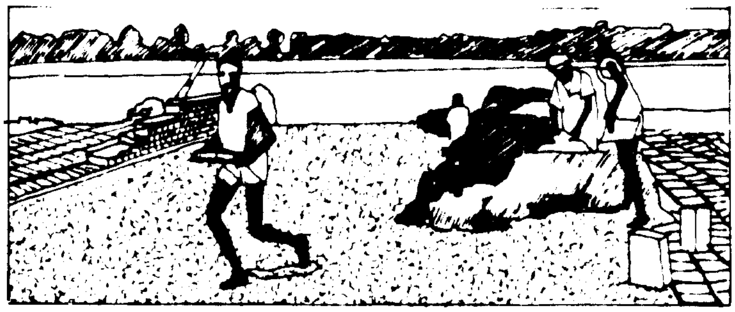
Even in 1978 in many of the ldc brickmaking enterprises, it can be observed that the wheel has not yet been 'invented'. Heavy loads of clay and bricks are manually carried from quarry to moulding station and to and from the clamp kilns. In many production units working conditions are atrocious, especially for the moulders and brick carriers, as illustrated in Plate 13. on the following page. These production workers endure

TRADITIONAL BRICKMAKING PROCEDURES IN AN AFRICAN PLANT

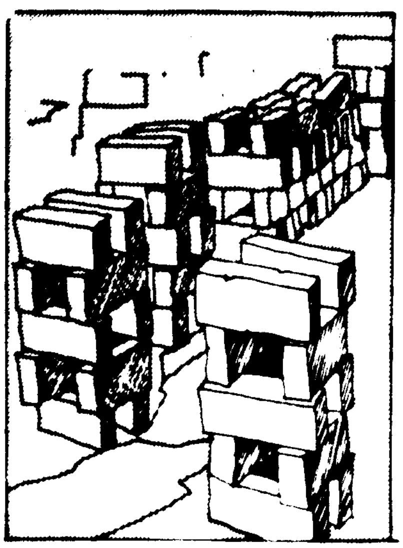
Clay dug and mixed with water, straw and animal dung at the river bank.

Taken by carrying litter to the moulder.

Moulder works with double compartment steel mould kept wet by dipping it in water trough.



Brick carrier takes bricks in mould to the drying ground, (fibrous material in the clay prevents cracking).



When hard enough to handle bricks are stacked for further drying.

When fully dry, loads of 50 bricks stacked on carrying litter.

Two men carry dry bricks up to the clamp for setting.

conditions of dirt and continual exposure to the full heat of the sun. In the event of unseasonal rainfall occurring, several days' production of bricks can be spoiled in one night and, for periods of the year during rainy seasons, the building trade can be brought to a standstill because of the absence of bricks. Gaps in the technology for many of these industries need to be filled but to avoid undermining the essential independence and strengths of the enterprises as described, the solutions proposed should be essentially low in capital cost and suitable to be maintained and operated using resources under the brickmakers control.

Most important of all is the need for a really low cost working shed consisting of little more than a supported roof under which to mould and to dry the bricks without danger of their being spoilt by rain. Many factory estates have been built in developing countries with conventional techniques and materials which are so expensive that their economic rent would frequently exceed all the wages' costs of the workpeople inside. This is precisely the kind of fixed cost element which needs to be avoided 'like the plague' in the running of a building material business. Instead, an elementary roof providing just a minimum $2\frac{1}{2}$ metre head clearance and similar distances between upright supports would suffice. Although less convenient than the high, wide-span roof, such a structure would involve a fraction of the cost and ideally should be built originally and later extended piecemeal, financed out of cash flow rather than involving raising capital for investment.

In the production processes it is clear that the traditional brickmakers are very responsive to simple ideas to improve working methods and numerous examples exist of equipment and techniques which have come into use once the benefits had been realised and the equipment became available. For example, brickmakers in Malawi have adopted a special clay breaking hoe with a weighted end, in the Southern Sudan they have recently taken to using wheel barrows, while in Honduras 'Scotch' kilns have come into use with corbelled brickwork fireboxes increasing control over burning. In Lesotho and Turkey horse propelled pugmills have been introduced to assist clay mixing while the Northern Sudan brickmakers now use accurately welded metal moulds in place of the wooden formers previously used.

Many problems remain unsolved at a low capital level and most of these are more generally applicable to a wider range of building components including roofing tiles, floor tiles, pipes and any other products made from clays, sands and aggregate. Priorities among these are as follows:-

1. Facilities to quarry materials in a form which produces an evenly proportioned material taken from the working face at all levels.

2. Better and lower cost means of obtaining and storing water for the production process. (Much of the process water used in traditional building material manufacture has to be physically carried from rivers.)

3. Simple systems for grinding and screening materials to the desired grain size.

4. Moulding and shaping systems which can work with the raw material in less wet and plastic form. Development of this kind would speed the drying process, saving space while at the same time producing items which are more likely to retain their original moulded shape without subsequent distortion.

5. Developments in the design of drying buildings to enable them to adjust for and make the best use of ambient conditions, catching all available wind when required but adjustable to prevent over-rapid drying in other conditions while also providing weather protection.

6. Improving utilisation of fuel by the development of simple techniques for continuous or semi-continuous firing of the products.

7. Developments of technologies to make use of the waste heat produced by other industrial processes such as charcoal burning, to dry or burn ceramic products.

8. Improvements to the design of hearths, grates and flues to make more efficient use of firewood for burning and new techniques for

burning agricultural and forestry by-products such as sawdust or chaff.

9. A system of hand operated industrial trucks or barrows to ease the movement of heavy or bulky materials around the process area including the loading of lorries. Conventional wheelbarrows are being used in some instances but they do not suit the handling of bricks.

One of the priority areas outlined above has already been taken up in a combined programme by the U.K. Building Research Establishment and the I.T. Building Materials Workshop to develop improved brick moulding techniques.

Implementation of Improved Technologies

It is one matter to innovate new technologies for building materials industries but another question entirely to formulate how these can be successfully tested and implemented.

From what has happened so far it appears that the informal mechanisms of the private sector have been far more effective in introducing new building material technologies than the efforts of the public sector through governments and the aid agencies. The original spread of traditional brickmaking and the village tile industries of Central America once introduced by Missionaries was usually spontaneous and imitative. The vast growth in private sector sandcrete brick and blockmaking in the 1960s and early '70s when cement was cheap also occurred usually without official assistance. What was needed in every case was the example of an individual or firm operating the business and obviously doing well out of it. Few entrepreneurs will embark on a new venture on the basis of a sales leaflet but need the evidence of their own eyes that the technology works and is economic.

It seems not to be enough simply to demonstrate the technology with a pilot plant and in the several instances where public corporation or government departments have themselves operated plants, the examples have perhaps been treated as 'government's province' and so not taken up by the private sector.

In the case of the latter, another factor influences circumstances, small scale manufacturing units generally operate better when the man in control is motivated by the fact that his decisions will directly affect his own livelihood. This leads on to the scarcity of individuals or cooperative groups who are prepared and able to take on the risks of entrepreneurship rather than just function as employees.

Two vital questions therefore need to be considered:-

1. How to introduce the new technologies in a form that they seem accessible and ready to take up.

2. How to find or create the entrepreneurs or cooperative groups to run them.

To introduce new tools and equipment is more than a question of just making them available in the hope that someone will take them up. The proposition needs to be 'sold' before the individuals interested in applying them could do anything about it. An organisation is needed to make potential customers aware of such matters as price, output capacity, operating costs, etc., and in the case of mechanised plant, a spares and servicing operation would be needed as well. From the point of view of public bodies, it is frequently easier to give things away than to sell them commercially, but this should be avoided at all costs. To receive equipment on over-favourable terms creates an undesirable beginning for an enterprise and will increase the possibility of its misuse. Instead any apparatus should be priced realistically at the cost the customer would expect to pay if he had to replace it or get it made for himself. This reinforces the specification of very low capital cost. Expensive equipment would be out of reach of individual purchasing power except on extended credit terms. The evidence from a review of the traditional brick industry is that the term 'undercapitalised', usually meant as a criticism, actually describes their strongest feature enabling them to survive the severest adversity.

Because the building material trade is such a volatile one, it is firmly recommended that credit facilities other than working capital should not be used as an important aspect of a capital investment. Projects should start at a size which is possible without the enterprise going severely into debt and additional facilities and equipment acquired out of earnings.

Creating a Suitable Environment for New Ventures

From government's viewpoint, the independent, small entrepreneur is difficult to accept as part of the economic community. He tends not to fill in official returns or pay taxes and, in many countries operates outside laws concerning minimum wage rates and working conditions. However, considerable tolerance needs to be exercised at this stage of a business' development because the very lack of a permanent establishment in the early years is symptomatic of incomplete commitment. Intervention by government to 'regularise' an embryo industry in the effort to make it respectable would often result in its extinction. The time for government to step in is after a period of consistent profitability when the entrepreneur himself begins to make his facilities more permanent for his own convenience, constructing a despatch office, installing a telephone, employing clerical staff, etc.

In the history of the Industrial Revolution many major, highly respected corporations began their existence working 'on a shoe string' and would most certainly never have survived the current legislative climate. One of the misfortunes of many developing countries is that a sophisticated banking and civil service structure has arrived on the scene ahead of the businesses which they were intended to regulate. Too much attention from the commercial and public sector - sometimes in the form of misguided help, can stifle a small enterprise before it has passed beyond the awkward adolescent phase.

With the smaller enterprises, attempts to establish the appropriate counterpart arrangements to meet government and the banks on their own ground can lead to dangerously high overheads. Formal book-keeping and accounts at a too early stage involve appointing full time clerical and accountancy staff, offices to accommodate them and related non-productive expenses, at a time when all the emphasis should be on making the product and establishing a market for it. The administrative embellishments are sure to come later when there is some money to count. Even worse, many new ventures begin life with a Chairman and Board of Directors appointed before the site is cleared. This phenomenon comes from the mistaken belief that establishing an orthodox company structure will somehow help a new venture off to a good start. The opposite is the case. The 'Managing Director' instead of sitting in the Boardroom arguing policies should be in the plant getting to grips with the new processes or out finding sales for the output.

Technical Assistance

At this stage the introduction of 'technical assistance' must be applied with great restraint. Even when freely given by the government or aid agency, professional advice, if provided in the wrong form can be a distraction and erode the self confidence of the new entrepreneur or cooperative group. All too frequently as a result of the original request for technical assistance being sent out in several directions, 'experts' arrive from several sources - as often as not giving conflicting advice which could have disastrous results. In selecting technical assistance the local counterpart department should first insist on professional help from individuals with directly relevant experience in the field concerned e.g. for a clay pipe project, it should be demanded that the expert has broad experience in this special field, not merely a general background in ceramic building materials. Of equal importance is experience in implementing projects in similar situations with a knowledge of all the problems involved in obtaining and sustaining resources.

Mitigation of Risk for New Ventures

Given; a) the availability of low cost tools for production, supplied by a 'selling' organisation with appropriate supporting arrangements, b) a benign environment of little regulation or government interference at the early stages, c) discouragement of managerial embellishment before the venture is ready for it and d) support from carefully selected technical assistance personnel; it may still not be possible to identify enough individuals or groups willing to shoulder the risks of going into the building materials business.

Taking on the responsibility of running a profit (or loss) making business constitutes a major step for anyone whose previous working life has been spent as an employee. In essence the risks come in three broadly defined categories:-

1. <u>Procurement</u>

Being able to obtain the essential resources required for the production processes without any one of which the plant is at a standstill. (A concrete blockmaker who cannot get his sand delivered is out of business)

2. <u>Production</u>

Having obtained the raw materials, the production process must be organised to turn out required numbers of acceptable products at the right level of cost. Failure to organise the production process properly leaves the business without sufficient products of the desired quality to sell. (The brickmaker who turns out bricks which consistently fall apart in the hand will soon cease operations)

3. <u>Marketing</u>

Many businesses reach the stage of having products ready for the market but then find difficulty in selling them due to competition or lack of basic demand. Even when the output has been 'sold', some customers, private and public, take a very long time to pay and sometimes never do. Without a sustained inflow of cash from sales a business can show a profit on paper but still go to the wall because of inability to meet commitments.

Government can do quite a lot to help fledgeling building materials undertakings by helping to mitigate either or both the 1st and 3rd category of risk. The procurement risk can be eased by official help in ensuring supplies of essential materials at consistent prices. For example, if it were decided to assist the implementation of small enterprises to produce handmade fibre-reinforced roofing sheets, official help could be given for instance in the procurement of cement where this commodity is intermittently in short supply in the open market. Alternatively, it would be a considerable help if, in the early days of the venture, lorry loads of the appropriate grade of sand were supplied by the Public Works Department.

The marketing risk could be lessened if the public sector undertook to purchase a guaranteed proportion of the output in the early days of a venture. In the case of a handmade roofing sheet project it could be arranged for the new product to be used in current school building projects or for public housing.

With two of the major areas of risk partially removed it would be far easier to attract an individual, who had never previously run any kind of business, who would embark upon a new venture. To be able to concentrate on getting the production side running well would be a great help at the beginning. Subsequently, what would probably happen would be that the need for the official procurement service would drop away as the businessman began to identify his own sources of supply. Similarly later on he would have time to look into the nature of the market and could well find that he could secure better prices from private sector sales and would need to make less use of the officially supported marketing arrangements.

At such a time a new building materials venture could be seen to be established and able to fend for itself, creating employment and adding to the country's G.N.P.

International Collaboration

To accelerate the programme for implementing appropriate technologies to assist the building efforts of poorer communities in developing countries, the most valuable work which can be done internationally will be to identify technologies which show most promise and bring them into a finished form to be marketed to the private sector, including the poorest rural communities. The technologies may already exist but their potential not yet be realised by application through marketing or extension organisations. Alternatively, they may be materials or production systems which are currently under development by organisations working in this field but which need to be made complete and workable in a fully appropriate form.

The physical form to aim for in the appropriate building material production technologies should meet the following prescription:-

1. Equipment that is simple to work with and be maintained by operators themselves.

2. Equipment suitable for duplication in the small metal working or carpentry workshops which exist in most ldc towns, at a cost realistically within the reach of the individual or group who aim to use it.

3. Producing materials or components which can significantly up grade traditional building structures, increasing durability, amenity or sanitation aspects.

4. Using the minimum of process materials, such as cement, which need to be paid for in cash or, as in the case of the fibre cement sheet for example, substituting a low cost purchase for a higher cost one.

The price of the equipment items offered to poorer community builders should not include any provision for the research and development investment which may have gone into evolving the technology, nor should the cost of promotion or marketing be reflected in the price. Instead, the aim should be to get the appropriate technology system into the hands of the beneficiaries at a cost to them which realistically represents what they would need to pay to extend the scale of operation later or replace the original equipment when it is worn out. The equipping of the poorer community builders will, therefore, in effect be heavily subsidised at the outlet but the subsidy will only apply to the initial introduction and once running, the ventures should stand on their own feet. It should be a part of the supporting extension services to show the local metal working or carpentry working shops how they can make the new production tools and to involve their resources in the development programme, providing the equipment for the small scale building materials manufacturers. Where time under the technical assessments arrangements is not available to carry out this work, full size models should be supplied for the fabricators to copy.

The programme will require the collaboration of the various governments and development agencies and in the circumstances described, avoid the national self interest of mere export promotion in the effort instead to assist the poor rural communities who hitherto have least benefited from the overseas aid programme.

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