BUILDING TECHNOLOGIES & MATERIALS PRODUCTION: Their Effect on Construction Costs, Complexity & Incomes and Employment in the Rural Areas. Sahiwal District, Punjab, Pakistan.

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CONTENTS

This paper is a summary anticipating the results of the dissertation on this topic. It has been prepared for discussion purposes only to clarify the form and content that the dissertation will take. The results of the analysis cited are indicative of expected findings rather than actual findings. SOme of these results were calculated from quantitative data and others are estimates from qualitative data from a sample study pre-testing the methodology. The estimates are marked with an asterisk (*).

1. Introduction

The potential of building construction within a rural development effort lies not only in meeting physical housing and building needs but also in promoting community participation and in enhancing rural incomes and employment. This Paper examines how the choice of technology can facilitate or inhibit these potentials of building construction. In particular, it examines how construction and maintenance costs and complexity and the income and employment generating capacities vary with the technology used. As cost and complexity increase, not only is the number of units that can be constructed reduced, assumption of greater responsibility by the community for the projects concerned is likewise inhibited. Furthermore much of the receipts from construction expenditures is leaked out of the district or a greater proportion of it accrues to upper-income groups and is spent for consumption rather than being invested, through rural materials industries and construction, in generating jobs among the rural poor. The technologies conventionally adopted in government funded community buildings tend to have these negative effects.

It should be possible to adopt a technology that results in an acceptable standard of building quality, reduces cost and complexity, stimulates demand in rural materials industries and increases the income and employment generating capacities of building construction. Thus building construction, given the current high proportion of public and private investment in it, can be a significant instrument for simultaneously facilitating community participation, enhancing rural income and employment and meeting physical housing and building needs.

1.1 Outline

The paper has two sections. The first examines how cost (and hence coverage), complexity (and hence community participation), and rural income and employment vary with the technology used in building construction. It establishes that these variations are significant in relative terms and indentifies the material industries and building technologies that are the most effective with regard to the above criteria.

The second section examines the determinants of materials' industries' and building technology choice in the public and private sectors. Taking these determinants into account, it outlines a rural building construction program using industries and technologies in a manner that will maximise coverage, participation and rural income and employment.

1.2 Methodology

A rural district, Sahiwal, and a particular sub-district (Tehsil), Pakpattan, in Southern Punjab were taken as case studies. Ten technologies and ten material production and supply networks in the district were analysed through case studies of public and private construction projects and materials industries.

General interviews were also undertaken with a range of relevant informants: owner-builders, masons, materials industries' proprietors and workers, government engineers, officials, & policymakers at the local, provincial and federal levels and community representatives. Altogether 95 case studies and 55 general interviews were undertaken. Standard engineering quantities and costing techniques for calculating technology costs were applied. A simplified input-output sytem was used to establish the backward and forward linkages of the materials' industries and building technologies. An ~~search flow~~ analysis of the Multiplier analysis established the income and employment generating characteristics of these industries and technologies.

A rating chart with a points system analysed complexity for each technology, using indicators such as the number and variety of inputs and discrete operations required, proximity of inputs to the construction site, perishability, and duration of construction.

1·3. Summary.

I. Materials Industries

Two sets of materials' industries emerge as potential substitutes for each other in the rural small scale construction sector-- Sun-baked and agricultural-waste-fired bricks, timber and lime versus coal and oil-fired bricks, steel and cement. The former set has low capital requirements, is simple to operate, uses rural inputs and offers lower cost products to rural markets, and generates the most rural employment and income, especially among the rural poor. As a set these industries meet the majority of the material inputs required for rural building technologies. However, unlike the latter set, they are not organised as an industry (i.e., lacking established inputs supply, production, product distribution and materials' use methods), receive no government support and have to compete with the latter set's subsidided input and product prices. They moreover have an 'image' of being traditional industries of little value to a modernising society. Consequently, cement, although more expensive and difficult to procure, has largely replaced lime and steel girders are becoming a more economical alternative to timber beams.

2. Building Technologies

Kucha technology costs the least and hence the most coverage (in floor area) can be achieved. It generates the most rural income and employment particularly among the poor through demand stimulated in local materials' industries and in construction. It is also least complex in terms of technology and construction management and most inputs may be contributed 'in kind' by rural comminities, thus facilitating community participation. However, as currently practiced, its low technical performance and strong associations with backwardness makes it unacceptable and most users would upgrade as soon as they could afford to do so.

Pukka technologies are too costly and too complex to be useful to most rural inhabitants. Their adoption in government buildings restrict the number that can be implemented, given limited financial, technical and managerial resources, and result in a substantial proportion of construction expenditures being leaked out of the district instead of generating local jobs and incomes.

Kucha-pukka technologies best combine least cost, least complexity and maximum income and employment generation with a technical performance and association acceptable to rural communities.

3. Proposals

A new set of kucha, kucha-pukka and pukka technologies along with their attendant materials industries - stabilised hand pressed bricks, agricultural waste fired bricks, tree farming & treated timber, and lime -- should be developed and promoted. The set of technologies are designed to meet minimum standards of cost, technical performance and acceptability for each stage of a range of income groups in the private sector and building quality in the public sector, and to upgrade in response to the required quality improvements.

These technologies and their materials industries should be tested and demonstrated in a pilot building program in one or two rural districts. The program should integrate building construction and materials industry development with education and training in planning, technology and management of such projects for local community and government representatives.

An external multilateral agency or an NGO with persuasive funding and credibility should collaborate with a government agency - the Local Government and Rural Development Dept.- in this program.

The respectability spinning off from the demonstration effect of the many dispersed government projects should be enhanced by encouraging key 'trendsetters' -- large landowners, retired government officials-- in the rural areas to adopt the technologies in their construction. The materials' industries should be joint ventures with low-income groups such as brick kiln workers (in the case of sun-baked and agricultural waste fired bricks production) and small landowners (in the case of tree farming) and devolve these industries to their ownership.

4. Extensions of Application

The proposed materials' industries can provide the inputs required for most basic infrastructure construction-- feeder roads, small bridges, culverts, irrigation and drainage ditches and street paving in rural areas. Since the same people (masons, industry entrepreneurs and community and government representatives) are involved in the materials production and supply and construction for both basic buildings and public infrastructure, the pilot project should combine both aspects of construction. (The study on infrastructure required in order to include it in the pilot project could be relatively quickly undertaken on the basis of this study on building.) The proposed technologies and materials' industries, with some modifications, could also apply to small-scale building & infrastructure requirements in the urban areas.

In effect, over the medium term, a small-scale construction sector could be developed applicable to both rural & urban, building & infrastructure whose industries are largely rural based and which would have a major impact in generating rural income and employment, it would relieve demand pressure on materials such as cement and steel essential for large scale construction and thus, reduce construction cost for this sector as well.

and small scale construction sector.

5. Future Implications

If the proposed technologies and materials industries 'catch on' substantially, the following may be expected: in the short term,

Causality not clear

(1) input + product prices will rise;

(2) resource shortages will occur;

(3) upper-income groups will take over profitable industries.

In the medium term, however, (1) resource shortages should ease as the new materials production and supply networks establish and expand; (2) input and product prices stabilise at a level slightly higher than at present as markets stabilise; (3) upper income groups revert to the more profitable industries supplying large scale construction as the latter's demands expands.

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2.1 Building Materials: Inputs, Production & Supply

The building materials produced within the district are sun-baked bricks, fired bricks, timber reed matting and low-grade sand. Those produced outside the district are cement, steel girders, T-irons, m.s. rods, aggregate, lime and high grade sand. Transport modes carrying inputs to the industries and materials' shops and from them to the construction site include donkey-borne bags and carts, tractor-trailers, buses and trucks.

.1 Sun-baked Brick Production

Almost every village has sun-baked brick makers, Thapairs, one or more households that produce these bricks, either as a main occupation or on demand when they are not engaged in agriculture. Some Thapairs expect the buyer to provide the material inputs - water, sand and earth, Often, however, these are leased from landowners who are paid upon the sale of bricks. Equipment required is minimal: a wheelbarrow, shovel and brick moulds.A minimum of 2 persons is required; one to prepare and transport the mix to the other who moulds the bricks. Several households sometimes group together to produce larger quantities for sale, particularly during the post-harvest construction season. Both the material inputs and finished products are transported by donkey bags and cart owners (Kumhars). The poorest sections of the community engage in this trade.

.2 Fired Brick Production

Two methods of brick production are practised. One, the trench kiln is coal and oil fired; the other, the wall kiln, is fired using agricultural waste, rice husks and cotton waste.

.2.1 Trench Kilns

Trench kilns are concentrated around large towns which are their main markets (Sahiwal with 152000 population, Pakpattan 70000 population and Ariffwala 44000 population) and along the major roads. The production process consists of making the sun-baked bricks and then firing them in an oval trench kiln. Land and water is leased from a landowner, sand purchased locally; coal and oil, the major production cost items, are trucked in from other provinces. The kilns' capacity range from 400 to 700thousand bricks. The labour force can therefore be sizeable (19-48 persons), made up of thapairs (5-15 households), kumhars (4-8 persons), loaders and unloaders (2-4), those who fire bricks (2-4) and accountant/managers (1-2).

Trench kiln owners are in the upper income group and are basically of two types: urban (large town) residents sometimes engaged in other occupations who own one or more kilns, and rural (small towns and village) residents, medium and large landowners or 'Pathans' a northern ethnic group who have settled in the district, initially as wood sellers, some of whom are now entering the kiln business. The bricks' market include towns, upper and middle income groups and the government. Their prices are fixed by the government. Sun-baked bricks and brick ballasts are also sold at some of the kilns.

.2.2 Wall Kilns

Wall kilns are located around the small towns and the major roads. These kilns were introduced into the area some 5-10 years ago by kiln workers travelling to and from the Sind province. The production process is similar to that of the trench kiln. However, instead of the oval trench, 2 sun-baked brick walls constructed in a V-shape spreading forward enclose the stacked bricks which are fired on rice husks. Unlike the trench kiln in which bricks have to be filled in a t a constant rate to keep up the firing cycle, the kiln's wall can be narrowed or widened, thus increasing or decreasing the number of bricks being fired without interrupting the firing. Kiln capacity ranges from 50,000 to 400,000 [illegible]. Rice husk and cotton waste, the major production cost items, are trucked in from the local grain silos and cotton ginning factories. The Thapairs [illegible] (2-6 households), [illegible]', are paid on a contract basis. The rest of the work is done by the kiln owners. The latter are usually a cooperative of 4 to 6 former trench kiln workers but not Thapairs. The bricks, costing less than the trench kiln ones, are sold largely to the lower-income groups in the surrounding villages and small towns. The government does not purchase these bricks as they are considered sub-standard.

.3 Timber

Local timber, Acacia and Shishum, are used for beams and battens as well as for joinery and furniture, No construction timber industry exists as such. Landowners grow trees and sell them periodically to sawmill owners or to wood sellers. The latter, stock and sell large numbers of these trees for fuel or to burn into charcoal or to sell them to sawmill owners.

Sawmills are located in the large and small towns and larger villages (above 2500 population). The saws are driven by diesel or electric motors purchased from cities outside the district. The motor is often also belted to drive a rice and flour mill. Sawmills sell timber as beams and battens as well as fuel. Timber sawing services are also provided. Some have hired carpenters to produce doors, windows and animal food troughs. The number of workers, including the owner/operator, range from 2 (the minimum required to run the mill) to 8 persons. In addition, the owner pays 2 persons on a contract basis to cut trees and komharsto transport them to his mill, Owners are from the middle-income group those at least able to afford the motor and saw as well as rent land on the periphery or within the settlements.

.4 Reed Mat Making

Most reed mats are produced by a migrant clan who work in the district for only a few months in the year. Land along the rivers where the reeds are grown are leased by the clan. Mats are produced in the same place. Other inputs, equipment are minimal, string to tie the reeds, hand tools etc made by the matman or purchased from the towns. The finished products are sold to shops in the towns, where there are also a few workshops making mats.

.5 Cement and Steel

Cement and steel girders, T-irons and m.s. rods are all produced outside the district. State operated factories distribute fixed quotas of cement by truck or train to authorised agencies in the primary settlements. Cement prices are fixed by the government. During shortages, which often occur, a magistrate's permit is required to obtain the cement. Periodically, cement is imported.

Steel girders, T-irons and m.s.rods are rerolled from scrap iron obtained from ship breaking yards. Products are trucked in from Lahore to shopkeepers in the large towns of the district. Transport from the shops to the construction site is usually by tractor trailer or bus.

In 1983, a state owned steel factory began production and sells to the domestic market at subsidised prices.

.6 Sand, Aggregate and Lime

Lime is produced outside the district and is trucked into shops in the larger towns. A lime kiln is located in the neighboring district but most of the lime comes from Northern Punjab where it is a main industry. Lime is used in small quantities mainly for white-wash and is sold by the materials shops in the large towns.

Only low grade sand is available within the district. along river beds and sandy soil areas. Depending on the quantity required, sand is delivered directly to the site by either the Kumhaars or tractor trailer operators both of whom pay landowners for the right to sell the sand. High grade sand is available from outside the district on order through material shop owners who act as agents. Large orders are delivered by truck directly to the site. Smaller quantities are available by the bag in shops in the larger towns.

Like sand, high grade aggregate is trucked in from outside the district to the construction site. Orders are placed through the materials shops. Low grade aggregate is available locally along dry river beds. Entrepreneurs lease land from the government, buy crushing machines and hire labour to produce the material.

2.2. Comparisons: Income & Employment.

Who are the beneficiaries of income received from purchases made in the materials' industries and what are their relative shares of this income? This question is answered by tracing the distribution of receipts as expenditures/payments to the different factors involved in each building materials' industry. Since we are concerned with how these industries affect rural incomes, in particular the low-income groups, beneficiaries are divided as follows:

(1) Spatially, between

(a) external: (urban sector) those in the large towns (population greater than 25000) and outside the Tehsil;

(b) internal: (rural sector) those in the small towns (less than 25000 pop'n.) and rural areas in the Tehsil.

(2) By income group

(a) upper income: landowners, proprietors of trench kilns, saw-mills and building materials' shops and highly skilled masons;

(b) lower income: workers in the materials' industries, unskilled workers in construction and transport, constructon workers with skills for kucha and kucha-pukka technology only, sun-baked bricks and reed mat makers, worker-proprietors of wall kilns.

Comparisons are made bewteen possible substitute industries since the underlying policy question is that, " If we wish to maximise local income multipliers and particularly income to the rural poor, which industries should we encourage?" The substitute industries are:

(1) for walls: sun-baked bricks, wall or trench kiln bricks;

(2) for roofs: timber or steel;

(3) for mortars and plaster: mud, cement or lime.

Bricks

Almost all the receipts (97%) from the purchase of sun- baked bricks are received by the brick makers who are from the lower-income group while only 4% go to the upper-income landowner as payment for the land, water and sand. Spatially, leakage of income to outside of the district is a negligible 0.5%.

For trench kiln bricks, leakage of receipts is a substantial 57%, paid out as fuel costs. A larger proportion of receipts retained in the rural sector goes to the upper income proprietors (23%) with 20% to the lower income workers.

The use of agricultural waste as fuel in wall kilns* reduces leakage down to less than 5%, the portion paid to the waste transporters, truckers, [often] from outside the district. Of the local multipliers, a smaller proportion (40%) goes to the upper-income groups- the landowner leasing the land, sand and water and the factory owner selling the agricultural waste. These commodities are as yet sold at very low prices and are not a significant production cost item. The bulk of the receipts goes to the lower-income groups, i.e., the coop owner/workers, and a small proportion to the brickmakers who are paid market contract earnings at subsistence rates.

Thus, in terms of maximising local multiplierd and benefits to the lower income groups through materials purchase of bricks, sun-baked bricks are the most effective channel. However, taking into account quality of the bricks, wall kiln bricks would be the best choice, being far stronger than sun-baked bricks but only marginally weaker than trench kiln ones and certainly strong enough for the majority of rural buildings.

Timber Vs. Steel

Less than 5% of the receipts from purchases of timber beams and battens is lost as leakage which consists of the costs of the motor and hand saw obtained from outside the district. Of the portion remaining locally, the upper-income groups--the landowner selling the tree and the owner-proprietor of the sawmill-- obtain 70%.

For girders and T-irons,* 90% of the purchase cost is leaked out of the district going mostly to the steel markets in the provincial capital, Lahore, and some to the truckers delivering to the local shops. And of the 10% local multipliers, a negligible 2% may go to the lower-income labourers loading and unloading the steel.

The choice here is clearly for purchasing timber. However, this choice is complicated due to price trends to be discussed shortly.

Cement, Mud or Lime

The distribution of receipts from cement purchases* is similar to that from steel since production and supply characteristics, vis-a-vis location and income groups, are the same. The only difference is that most of the 90% leakge goes to the state cement factory rather than to private entrepreneurs as is the case of steel.

Mud, used as a substitute for cement in mortar and plaster work, would clearly have negligible leakage both spatially and to upper-income groups. In the case of the latter, it is only that amount paid to the landowner for the use of mud on his land.

Where higher quality bonding and plastering than mud can provide, is required, lime has long proven as an effective substitute for cement. Lime is also produced outside the district and the receipts' distribution would be similar to that of cement in terms of our study area. However, since lime kilns, like those for brick, are a rural located, labor intensive operation, these receipts are generating more rural incomes than cement factories, albeit elsewhere. Furthermore, lime kilns could be introduced in Sahiwal district, but the cost of transporting limestone may make the local kilns uneconomical. the presence of a kiln in the neighbor district suggests this may not be so Lime is cheaper than cement as a mortar and plastering agent. In recent years, this use for lime has markedly decreased which may have more to do with factors such as 'images of modernity', specifications of government buildings, and cement being an organised industry while lime is left to the informal sector, etc. These issues will be pursued in a separate section.

2.2. Price Trends

Wages have been increasing at a slower rate than the real costs of energy - coal, oil and electricity. Thus it could be expected that the production and supply costs, and therefore, product prices of the labor intensive industries, the inputs and markets of which are also in close proximity, would rise at a slower rate than those of energy intensive ones. the inputs and markets of which are far from their production centres. If so, the prices of sun-baked bricks and wall kiln bricks would rise at a slower rate than trench kiln bricks. Timber prices would rise slower than steel; mud and lime, slower than cement. These expectations are, however, modified by other factors influencing product prices.

Energy prices- coal/fuel and motor oil- and the prices of key materials such as trench kiln fired bricks and cement are fixed by the government, and price rises have been steep Although these are regularly upgraded, real production costs are understated. I.e prdn. is not profitable?

[illegible].

Certain materials have been organised on an industrial basis with heavy government support while others have been neglected. This applies to steel versus timber and cement versus lime. The ship-breaking industry which provides cheap scrap iron, a major input for steel girder and T-iron production, has been expanding rapidly. A large, capital intensive steel plant has recently opened supplying at subsidised rates to the domestic market.

On the other hand, timber, even in the Northern areas which is the major source, remains a disorganised and fast depleting resource. one of the factors underlying this bias is the perception that concrete and steel are the [illegible] industries of a modernising society; worthy of government support unlike [illegible] timber and lime which are those of a past traditional' one.

Certain local factors can also be expected to influence prices. If the demand for sun-baked and wall kiln brick & therefore its inputs increases significantly, then input [illegible] - earth and agricultural waste and product prices would also increase. The early kiln operators used to obtain the agricultural waste for free from the factories. Land values and therefore earth prices also increase as settlements urbanise. Nevertheless, given relatively equal improvments in production technology, wall kiln and certainly sun-baked bricks would remain significantly cheaper than trench kiln bricks.

Over the past years, the prices of steel girders and timber beams have alsmost equalised to the extent that, given the shorter life span of the latter, even kucha houses are using steel girders. The first reason, alluded to earlier, is that unlike steel, timber for construction is not organised as an industry. Its supplier, the landowner, typically grows trees as an incidental source of income, Furthermore, timber is used untreated and in a manner making it particularly prone to moisture and insect attack by those who cannot afford steel. This misuse reinforces the view that it has no potential as a construction material. Thus neither the demand nor the supply of it has been developed on a market basis.

Secondly, timber beams of sufficient size to be used in roofs are becoming increasingly scarce and therefore expensive because the trees are being cut young for fuel wood and charcoal. However, timber battens which can be obtained from the younger and smaller trees continue to be a cheaper, more widely adopted alternative to T-irons.

At present, the small scale construction sector has substitutes for the materials-- fired bricks, steel and cement-- that are essential for large scale construction. As Pakistan's development program continues to expand, the demand and, therefore, the prices of these latter materials can be expected to continue their steep rise. If the substitute materials industries are developed (sun-baked bricks, wall kiln bricks, timber and lime), it can be expected that switching some of the small scale sector's demands to these substitutes will provide this sector with more affordable alternatives as well as relieve some of the demand and consequently the pressure on prices of materials essential for large scale construction. However, with these substitute industries fast declining the increasing demand and prices will continue to accelerate construction costs making development expensive for both the government and the individual owner builder.

BUILDING TECHNOLOGY TYPES.

	No.	Type		WALL.	FLOOR	FINISH.
EXISTING	1.	KUCHA	1.	Sun-baked brick in mud-mortar. (13½" wall) arched lintels.	Timber beams, battens, reed mats, grass & earth fill.	Floor: Packed earth, mud plaster, dung finish. Walls. mud-plaster, dung finish. Roof: " " " "
	2.	KUCHA/PUKKA	1.	Fired brick facing on sun-baked brick wall (Ghilafi) in mud-mortar (13½" wall) arched lintels.	Timber beams, battens, fired brick (clay) tiles earth fill.	Floor: packed earth, mud plaster or brick paving. Walls: interior mud-plaster & dung finish. Roof: " " " "
	3.	PUKKA	2.	Fired brick in mud-mortar (9½" wall) reinforced brick (r.b.) flat lintels	Steel girder, T-iron battens, clay tiles earth fill.	floor: packed earth, mud plaster or brick paving. Walls: exter: cement plaster or pointing, int: cem. plaster Roof: mud plaster & dung finish.
	4	PUKKA	1	Fired brick in mud-mortar (9½" wall) w/ or w/out d.p.c. reinforced brick (r.b.) flat lintels.	Concrete reinforced brick slab, (RBC) w/ or w/out dpc. earth fill.	Floor: packed earth, brick ballast, cement plaster. Walls: Ext. cement pointing or plstr. Int. cement plaster. Roof: mud plaster & dung finish.
	5	GOVT.	2	Fired brick in cement mortar (9½" wall) with dpc. r.b. flat lintels.	Steel girder, T-iron battens, clay tiles. dpc. earth fill.	Floor: packed earth, sand, brick ballast, concrete, cem. plaster. Walls: ext: cem. point. or plaster, int: cem. plaster. Roof: mud plaster, dung finish.
	6	STANDARDS	3	Fired brick in cement mortar with dpc. (9½" wall) reinforced cement concrete (rcc) lintels.	Reinforced cement concrete (RCC) slab. dpc., earth fill, mud plaster, clay tiles in cement mortar.	Floor: packed earth, sand, br. ballast, concrete, cement plaster. Walls: ext. cem. plaster or pointing: int. cem. plaster. Roof: clay tiles.
	7		4	Fi... as above.	Precast concrete (pcc) girders and tiles. dpc, earth fill, mud plaster, clay tiles in cement mortar.	As above.
PROPOSED	8	KUCHA	1.	Sun-baked brick in mud-motar. (13½")	Treated timber beams & battens & reed mats, dpc, earth fill. or sun-baked brick vaulted roof, dpc, earth fill.	floor: packed earth, mud plaster & dung finish. Walls: mud plaster & dung finish. Lime point. on ext. fired brick. Roof. mud-plaster, dung finish.
			2	Fired brick in lime mortar at base & parapets & cills, arched lintels & encasing beams & dpc or as above but 24" thick walls.		
	9	KUCHA/PUKKA	1	fired brick facing on sun-baked brick wall (Ghilafi) in mud-mortar. (13½") arched lintels. dpc.	Treated Timber beams, battens & planks dpc., earth fill. or fired brick vaulted roof. dpc, earth fill.	Floor: packed earth, sand, brick ballast & cement plaster. or " " tiles in cement mortar. Walls: Ext. lime pointing or plaster. Int: mud plaster, dung finish Roof. mud-plaster, dung finish.
			2	Also fired brick as above 8.1. or as above w/ 24" wall.		
	10	PUKKA	1	fired brick in lime mortar (9½")	Steel girder, T-iron & tile, dpc. earth fill. or fired brick vault, dpc, earth fill.	Floor: as 9.1. Walls: Ext. lime pointing or plaster. Interior lime plaster. Roof: mud plaster, dung finish.
			2	or " " " " " (24")		

3.0 Building Technologies and the Construction Process

3.1 Building Technologies

There are approximately 9 types of building technologies practiced in the district. These can be grouped into 3 basic types: kucha, kucha-pukka and pukka. These are described below.

(1) Kucha. There are 2 types under this group. First, those with walls of earth-cut blocks and roofs of rough hewn timber, grass and mud. Second, those with walls of sun-baked bricks and roofs of sawn timber beams and battens with reed mats overlaid with mud. Floors and finishes are of mud straw plaster with a thin cow dung finish. (see fig.)

(2) Pukka. There are 4 types here differentiated primarily by the roof construction- (a) Steel girder beams and T-iron battens with fired clay tiles; (b) Reinforced concrete roof slab; (c) Reinforced cement concrete roof slab; (d) Pre-cast, cement concrete beams and battens (PCC) and tiles. All four have a polythene waterproofing membrane and mud topping. Walls are of fired brick in cement mortar and floors and finishes of cement concrete and cement plaster.

(3) Kucha-Pukka. There are 2 types under this group- (a) Walls of fired brick facing with sun-baked brick backing laid in mud mortar (Ghilafil type) and roofs of timber beams and battens with clay tiles; (b) Walls of fired brick in mud mortar and steel girder and T-iron beams and battens with clay tiles. The roofs of both types are overlaid with mud-straw plaster and cow dung & occasionally the exterior wall may be cement plastered.

Approximately 80% of the rural buildings are of the kucha type, some 18% are of the kucha-pukka type and approximately 2% of the pukka type. On the fringes of technology types are, on the one hand, the tents and wattle and daub structures of the very poor or nomadic groups and on the other, the large, steel truss, wide-span roofs used in factories, warehouses and grain silos of government and private enterprises. The PCC roofs are also a very recent introduction and there are only a few existing examples. However, since they are being seriously considered as a low-cost alternative in housing and community buildings, they will be discussed.

3.2 The Construction Process in the Private Sector

3.2.1 The Individual Owner-Builder

The low-income owner-builder (agricultural laborer, unskilled manual laborer) uses kucha technology. He collects or makes the required materials over an extended period, ranging from 1 agricultural slack season to as long as 2 years. He usually constructs his house during one of the slack seasons and informs his friends and neighbors when he may need assistance such as in laying the roof. The adult males undertake tasks such as digging and laying beams and battens. Women may assist in mixing & carrying mud and straw for mortar and finishes. Plastering is almost exclusively the job of women assisted by children. Masons are hired to lay the brick walls.

Middle-income groups (small land owners, shopkeepers, service and craft workers and petty government employees) may also use kucha technology or kucha-pukka. They tend to purchase more of the materials used, hire sun-baked brick makers, etc rather than make the materials themselves. They will hire masons and labour although they may perform some unskilled tasks themselves in addition to managing the construction process. Most of the wealthier residents also use kucha-pukka technology.

The few very wealthy owner-builders (large landowners, Middle East returnees and retired government officials) construct pukka houses. They are generally able to marshall resources 'in kind' due to the power and influence they have, e.g., borrowing formwork from the local government official resposible for building construction, using agricultural workers from their farms to construct the building, etc. Skilled masons and some labourers are hired. Those who have no access to resources in kind pay cash for most of their building inputs. (In the 3 small towns included in the study, there were only 6 examples of pukka construction.)

In both kucha and kucha-pukka, the construction technology and process provide shelter with very low cash requirements. Very few of the inputs (e.g., steel girders) require immediate cash to purchase. Most inputs can either be provided by the owner himself on a self-help basis (e.g., making sun-baked bricks) or obtained from the community on an informal mutual assistance agreement (e.g. labour for roof construction), or obtained on credit from a local supplier (e.g., timber beams and battens, see cases Nanakpur and Boyle Gung). Furthermore, because the materials are generally available within the immediate locality, transport costs are minimal or much lower compared to that incurred in pukka technology.

Finally, for all 3 technologies, costs are reduced because the construction cycle is in tune with the rythm of the agricultural cycle. For instance, bricks are purchased when their prices are lowest i.e., during the busy harvest season; labour, whether paid or donated, is obtained during agricultural slack periods.

3.2.2 Community Building Projects (e.g., mosques, schools)

These are projects funded and and implemented entirely by the community. The Majority of these are kucha-pukka except for a few cases wherein particularly wealthy donors involved may insist on pukka technologies (see Qabula case example). Generating interest and assistance for the project is undertaken through the weekly prayer gathering at the local mosques, followed up by individual contacts. A 'Project Committee' consisting of the major donors and/or interested parties such as the local 'imam' (prayer leader) or school teacher is usually formed. Names of donors and the amount of donations in cash or inkind are announced over the mosque loudspeaker to commend those assisting, prod others who have not and insure some measure of accountablility for the contributions collected on the part of the committee members (Village 28/SP case).

The points made earlier concerning keeping cash requirements to a minimum also apply here, and perhaps to a greater extent. A brick kiln owner or the timber sawmill operator donates materials or sells at concessionary rates for the mosque being constructed in his community. Similarly, skilled labour is obtained free or at reduced rates.

3.3 The Construction Process in the Public Sector

The public sector uses only pukka technology. There are 10 government agencies funding and/or executing building construction such as offices, staff residences, schools, and health centres. Five of these agencies have their own engineering sections to design and execute their projects and 4, the social sector agencies, leave execution to the buildings department.

The funds are allocated and standard designs and technologies for different buildings are established at the respective agencies' head offices in the provincial capital, Lahore. Project locations are also decided there and funds, standard drawings and instructions are sent down to the agencies' local office at the district level headquarters, Sahiwal. There, the agency engineers are responsible for modifying drawings, if necessary, to fit the particular site, tendering the project out to contractors in Sahiwal and supervising construction.

In the last few years, the federal government has revived a local government system focused on the planning and implementation of rural development projects at the local level. Two agencies, Local Government and Rural Development, were merged to oversee this system. The local government structure consists of local elected representatives forming councils at 3 administrative levels: (1) the Union Council representing a group of villages; (2) the Markaz Council, consisting of several union councils; (3) the District Council. The Local Government and Rural Development Department assists and oversees the local councillors in their functions through key personnel at each level, namely: the Assistant Director at the district level, Project Managers at the markaz level, and Union Council Secretaries at the union council level. The local councils get a share of the annual development programme funds as well as allocations and grants from the funds of the local government and rural development department. The latter has its own network of engineers down to the markaz level.

Development projects have historically been almost entirely construction related-- rural roads, culverts, irrigation ditches, village water supply, schools and health centres in addition to the department's own building requirements for offices and staff residences. In the last few years, the Health and Education departments have turned over the execution of some of their smaller buildings to the rural development department. The number of projects contracted out have been reduced and those implemented by the department's (Local Gov't. and Rural Development) own staff or by the project committees organised by the local councils have increased in recent years. The project committees consist of the department's staff, elected councillors and other community representatives. community participation is also encouraged through matching grant schemes. At the same time, the department, like the other government agencies, seem to be adopting higher technical standards for its buildings. For example, the markaz offices constructed in 1983 used reinforced cement concrete roofs in contrast to girders, T-irons and clay tiles in previous years.

Approximately 20% of the total development budget of the Punjab Province is spent on building construction projects. The social infrastructure sector has the largest construction budget and also spends the largest proportion of its total allocation on building construction (68%), followed by the physical infrastructure sector (11.5%) and the production sector (7.6%) (figures for 1979-80, Punjab Annual Development Programme). Thus building construction plays a significant part in development activities and expenditures in construction are a substantial proportion of the total government investment in development.

4.0 Comparing Technologies

4.1 Costs and Coverage

Initial construction costs and costs including repair and maintenance for over the expected lifespan of the building was calculated for each technology. These calculations were done in 2 ways: (1) by monetising all inputs; (2) by monetising only those inputs not usually obtained 'in kind' or on a self-help basis by the owner-builder or the community. The latter method is useful in understanding the predominance of certain technologies in non-cash rural economies and also in assessing which technology would be most appropriate in government building projects that expect community participation.

Monetising all inputs for initial construction, kucha technology costs Rs.20.8/sq ft, kucha-pukka ranges from Rs.44.3 to 49.6/sq ft, and pukka technology ranges from Rs. 56.6 to 67.9/sq ft. The more than doubling of costs between kucha and kucha-pukka technologies are due to the material inputs required -- brick, steel girders and T-irons. The 226% cost increase from kucha to pukka are due to extra material inputs -- formwork for concrete, cement, MS rods, aggregate as well as skilled labour and the longer construction duration required.

For the same construction expenditure, if we switch from pukka to pukka-kucha the increase in coverage (in terms of floor area) is 32.3%; from pukka to kucha, 198% and from pukka-kucha to kucha, 125%. Thus substantial increases in coverage may be obtained by switching technologies used.

Cost comparisons taking into account repair and maintenance are problematic since these would vary with: (1) the quality of initial construction; (2) the regularity with which repair is undertaken, thus staving off major defects from occuring and consequently more costly repair, and (3) the projected input prices over the period for which maintenance costs are considered. Masons and engineers with equal fervour argue that as long as initial construction follows correct specifications and minimal but regular and timely maintenance is undertaken, a building could last forever. Masons speak of kucha buildings and engineers of pukka ones. The pattern of maintenance adopted in the study is based on the following:

(1) Interviews with masons and engineers and getting them to describe the likely patterns of maintenance given the current standard of construction and repair practiced in rural Sahiwal.

(2) Interviews with owner-builders of houses more than 15 years old.

(3) Interviews with new or recent house owner-builders concerning their anticipated maintenance patterns.

(4) Personal observations of housing conditions.

The input prices and their availability are assumed to remain as p present. Costs over a 25 year period are taken.

Monetising all inputs and including repair and maintenance costs, kucha-pukka is only slightly more expensive than kucha which has much higher maintenance requirements.* However, although the cost margins between kucha and pukka and between kucha-pukka and pukka are reduced (relative to those for initial construction costs alone), these remain significantly large. The reason for this is th that although fewer repairs are required in pukka, these are far costlier than the more frequent repairs required in the two other technology types.

If only those inputs that would require cash outlays were monetised, the present values would revert to the wide differences reflected in intial construction costs.

The likely repair patterns adopted are as follows:

(1) For kucha technology:

(a) annual mud plastering of exterior walls and roof;

(b) every 10-15 years, rebuilding half a wall, parapets and one roof bay -- 1 beam, 13 battens, 4 reed mats and mud topping;

(c) every 3 years, mud plastering of interior walls and floor;

(d) every 25 years, replacing the whole roof and rebuilding half a wall.

(2) For kucha-pukka technology:

(a) annual mud plastering of roof;

(b) every 3 years, mud plastering of interior walls and floor;

(c) every 10-15 years, partially rebuilding base of wall and parapets.

(d) every 25 years, rebuilding 1 roof bay including replacing 50 clay tiles.

(3) For pukka technology:

(a) annual repair of cement concrete on floor and mud plastering of roof;

(b) every 5 years, repointing or replastering base of walls;

(c) every 20-25 years, major repair to roof caused by weak concrete mix, flourescence in bricks and corrosion of steel work.

4.2 Income and Employment Multipliers

The same sub-groupings - spatially and between income groups -- used in comparing multipliers in the materials' industries are applied here.

Investment in construction using kutcha technology generates substantially more local multipliers (99%) than using kucha- pukka (60 to 70%) and using pukka (52%). The 1% leakage in kucha is due to the purchase of reed mats from shopowners in the large towns. The substantial leakages in kucha-pukka and pukka technologies are due to purchases of oil and coal(for firing brick), steel girders and T-irons in the case of kucha-pukka, and formwork, cement, aggregate and m.s. rods for pukka. All these are externally obtained materials. If agricultural waste fired bricks were used, leakage would be reduced in kucha- pukka by 10-15%* since bricks constitute 23% of total costs of which 57% goes to coal and oil purchases in the brick industry.

Employment in construction does not vary significantly between kucha and kucha-pukka (1.5 versus 1.2 man days of employment generated per Rs. 100 expenditure) but is almost halved in pukka (0.8 man days). (The employment multipliers in the materials' industries were not calculated i n the sample study).

In kutcha technology, 77% of construction expenditure is captured by the lower income groups. In Kutcha-pukka, this percentage drops to 45 to 50% and in pukka, it is further reduced to 38%. The benefits to lower income groups through a share of the payments for construction thus drops substantially as we move from one technology to the other.

4.3 Complexity and Community Participation

Technology complexity affects community participation in 3 ways. Firstly, the more dissimilar to traditional practice a technology is and the more complex its application relative to the knowledge and expertise of the community, the more it will inhibit its members from participating in the choice of technology and technical supervision. Secondly, the greater the number of inputs that cannot be contributed 'in kind' but must be purchased in cash, the lower will be the level of community contribution since cash is in short supply in rural areas. Finally, the larger the number of inputs and the greater their variety, the more difficult the procedure for obtaining them (factors include distance of source to construction site, bureaucratic procedures as permits for cement, bulkiness and difficulty in handling and transport), the greater the number of discrete operations required in the construction process and the longer the duration of construction, the more it will inhibit the community from accepting mamagerial responsibility for the project.

Applying these indicators of complexity, it will be apparent as we move from kucha to pukka technologies in building projects, the tendency will be for community participation to be progressively reduced. This assumes that the communities' capacities in technical knowledge, income levels and managerial expertise remain constant.

However, if a small increment of complexity promises a substantial improvement in building product, this increment may in fact increase community participation by stimulating its 'willingness to participate'. Thus a community may not be moved to contribute to a project, although it has the capacity, if it feels that the result will not be a worthwhile building. Conversely, a community may be spurred to dig deeper down into its resources if it is motivated by the promise of a result it can be proud of.

Given the above assumptions, it is likely that the choice of kucha-pukka technology for a building project may inspire a larger community contributionthan kucha or pukka. Kucha technology, as cur-

currently practiced and perceived, had little 'pride value' Pukka technology requires technical knowledge, cash inputs and managerial c capacity much beyond most rural communities' resources regardless of their willlingness to contribute.

4.4 Summary

Kutcha technology is least costly, least complex and generates the most rural income and employment per unit of expenditure. However, because simple but necessary standards and specifications are not followed in its use, it is highly vulnerable to weather and termites and consequently has high maintenance requirements. Although accounting for maintenance in present value termsdoes not make kucha costlier than other alternatives, the high maintenance has a 'nuisance value' and reinforces kucha's strong associations with ' sub-standard shelter.The technology as currently practiced is unacceptable to individual owner-builders if they can afford any better and to the community for community buildings.

Pukka technologies are too costly and too complex to be adopted by the vast majority of rural inhabitants. Their complexity also results in sub-standard construction(caused by low technical supervision and expertise) requiring less regular but more costly repair. THe adoption of pukka technology in government buildings results in a high proportion of building investment being leaked out of the district instead of generating local jobs and income. Its cost and complexity results in omly a small proportion of total building requirements being met given limited financial and managerial resources.

A kucha-pukka technology with ghilafi walls using wall kiln bricks and roofs of timber beams and battens, clay tiles and mud-topping most effectively combines least cost, least complexity, local income and employment multipliers with achieving minimum acceptable standards amongst rural people. If trends in price differentials between steel girders and timber beams persist, girders would replace beams, sacrificing some local multipliers for lowering the cost.

Figures derived from building expenditures of one department, Health, in Sahiwal district, showed that if the department switched to kucha-pukka the percentage increase in local multipliers would be 33%, in the share of multipliers going to the lower-income groups, it would be 93.8%; in local employment generated, 126% and in extra coverage, 53%.

Almost 20%percent of public development expenditures are in building construction. If the public sector switched to kucha-pukka these expenditures could significantly enhance rural incomes and employment, particularly among lower-income groups and at the same time increase the coverage of community buildings.

Thus given present conditions, a program promoting kucha-pukka in private and public buildings is recommended.

5.0 Determinants of Materials Production and Technology Choice

The first section analysed how cost, complexity, income and employment varied with technology choice in building cinstruction. It showed that variations are significant and suggested that 'kucha-pukka' technology best meets the criteria of least cost, least complexity, maximum rural income and employment generated while meeting minimum acceptable building standards.

In this section, the major determinants of technology choice and materials production in the private and public sectors are first discussed. Taking these determinants into account, a program for rural building construction is proposed.

5.1 The Private Sector

By and large, the owner-builder, given his resources, makes a rational assessment between cost and performance in the choice of building technology he will use. Kucha technology, as currently practiced and maintained is clearly sub-standard vis-a-vis moisture and termite attack. Anyone who can afford to will upgrade to kucha-pukka.

Over the last year, as steel girder prices dropped and timber beams became more scarce and hence expensive, owner-builders also rapidly responded to cost differentials that affected particular part of a technology. Leaving the rest of the house intact, kucha house owners switched to girders as the margin between girder and timber beam prices narrowed.

However, the rational choice is also influenced by associations owner-builders make between technologies and poverty and progress. The more socially mobile middle and upper income groups are particularly sensitive to these associations. For example, a shop owner who has lived most of his life in a'ghilafi' house (a type of kucha-pukka technology) and finds no fault in it nonetheless chooses to construct the walls of his son's new house in fired brick. He explains, "New houses should, of course, be pukka."

What is perceived as modern and new soon becomes aesthetically preferable. Thus while everyone, masons and owner-builders alike, say arched doors and windows are stronger and certainly cheaper than flat lintels even of reinforced concrete construction, most consider the latter aesthetically more pleasing. Ironic in that at present in larger cities such as Lahore, there is a renaissance of the arch particulalry among the upper income groups.

The 'demonstration effect' also plays an important role in influencing technology choice. Reasons given for adopting particular technologies or for not implementing certain improvements are often ".. this is what everyone is doing nowadays..." or "..no one does that anymore.." A noticeable style in the facade of many new houses in geographically distant settlements is a copy of the many union council offices constructed by the government.

Resale value does not seem to be considered an important factor in technology choice, at least in the small towns and rural areas. Owner-builders are not interested in reselling, protesting that they have taken too much trouble constructing the house, need it themselves and besides they do not have the slightest idea how much it cost them and how much they would be willing to sell for.

Despite repeated inquiries, no case of someone having either purchased or sold a new house was observed. Where owner-builders can draw heavily on their own self-help and community assistance for labour and materials, it becomes far more economical to construct one's own house than attempt to raise cash to buy one. Furthermore, most families do not envisage moving permanently from their traditional settlement. The construction of a kucha-pukka or pukka house is seen as a one time effort to establish a family home for many years to come.

As for the entrepreneurs in the materials'industries, two factors are most striking. One is the willingness to attempt a venture with very little capital, apparent knowhow and assurance of success. The demonstration that someone else has been successful and some rudimentary knowledge of how to operate the venture are all that are required. Thus the largely illitrate donkey cart operators (Kumhaars) band together to run the agricultural waste fired kilns, stating that, "One of their members had seen it work in Sind province, and God willing, it would work for them."

The second factor is the great deal of trust on which business between private enterprises are conducted, a marked contrast from the extreme suspicion and wariness with which the government and its representatives are generally viewed. It is accepted that few have immediate cash to spare. At the kiln owners' phone call, coal suppliers from another district deliver on the promise of payment when the bricks are sold. On the other hand, the constant need to pay off tax inspectors, officials from the power department, labour inspectors who are not there to enforce the law so much as to make a buck from threatening the entrepreneurs with payment of a fine for a law they have not broken is a recurring story among small businesses.

Influencing technology choice therefore requires simultaneous action on several fronts. Firstly, the alternative proposed must clearly be a substantial improvement in performance relative to its extra cost or, conversely, it needs to be much cheaper than the more expensive alternative and yet perform almost as well.

Secondly, practical projects should convincingly demonstrate the alternative's superiority in cost/performance. Finally, the proposed 'improved' kucha and kucha-pukka technologies, to be acceptable, need to be disassociated from their current image of sub-standard construction fit only for the poor. Actions will have to be taken ranging from changing the terminology (to get away from the heavy bias in words such as 'kucha', i.e., weak, raw and 'pukka' i.e., strong, solid) to constructing prestigious buildings such as markaz offices.

Similarly, to attract private rural entrepreneurs, the proposed materials industries would have to: (1) require from them very little cash investment at the outset; (2) be relatively easy to operate in terms of the technology and management; (3) demonstrate its feasibility by insuring a market at the outset and subsequently a profit making capacity; (4) not least overcome the wariness towards government by perhaps having a quasi-governmental agency be the 'front' for introducing these schemes.

5.2 The Public Sector

Ideas and experiments to lower building costs through interventions in technology and, to a lesser extent, materials' industries have been undertaken by the government for the last 20 years. In particular, the case for 'low cost, indigenous resource use' has been repeatedly pushed. However, the practice has been a steady movement towards the more costly and complex materials and technical standards in government construction. Why? Several reasons can be identified.

(1) <u>Weak link between research and development (R&D) and executing agencies</u>.

No mechanism exists to introduce R&D results into government practice. For example, pilot projects are generally funded and implemented by an external or special agency (CARE , for example, see Case)with minimal involvment of a government executing agency or thought ~~to~~ how project findings may be adopted to the agencies' regular practice.

The weak link is further explained by the very low value attached to R&D by the other sectors of government. The Building Research Station, starved of funds and with little political influence is at present deemed a hardship post in government. The engineers in the field, i.e., those in the executing agencies, are considered to have all the power. Only one career research officer who has been with the station for years retains enthusiasm for his work. The rest complain of being in a'deadend' promotionwise, or are marking time till they are moved to 'the field'. Most experiments were undertaken during the initial years of the institution and only in the last several months ,with the expansion of the housing budget in the 1983-88 Five Year Plan, has some interest been expressed in reviving experiments.

Another contributing factor is that technical R&D seldom extends to R&D on the socio-economic aspects of the innovation. The marketing of innovations is ignored, i.e., neither its economic feasibility nor the question of how the product could be sold to the private and public sectors are addressed.

(2) System Rigidity

The sytem of planning and executing building projects is predicated on the use of pukka technologies, fired brick, cement, steel, cement and concrete. Standard designs and specifications, costing and funding procedures, construction and contract documents, tedering to contractors and technical supervision are set out with these technologies in mind. Executing personnel, from the chief engineer in the buildings' department to the sub-divisional engineer at the markaz level as well as the authorised contractors are all generally trained only in pukka technologies. Technical specifications and cost analysis for kucha and kucha-pukka technologies are included in government documents. Some engineers, particularly at the local level, have knowledge of these technologies. However, neither source is utilised and their existence is even unknown to some engineers.

Similarly, materials industries such as wall kiln bricks are too small scale to be even considered by the Small-scale Industries Corporation, or those such as timber fall between the jurisdiction of two departments - Industry and Mines, and Forestry. The latter's concern is to plant and auction wood to large contractors as well as to encourage tree-planting campaigns based on social incentives.

(3) Image Bias

The public sector shares the 'image bias' apparent in the private sector and helps perpetuate it. Cement and steel are associated with 'modern industries' and pukka technologies with modern buildings. These industries receive priority in economic planning and government funding. Pukka buildings spread to the rural areas the standards of modernity. Innovations using cement and steel, such as RCC beams, battens and tiles catch on since the infrastructure for materials supply is in place, their costs subsidised and their acceptability paved by their modern associations.

Building projects, because of their high visibility serve a valuable political propaganda function for their sponsors and those that execute them. Typically, the patron has time to see only one building and its immediately visible physical impact overrides the less tangible socio-economic costs and benefits. Thus the one pukka modern building serves its political function better than several modest ones constructed with the same budget and which may have also used more community participation and generated more local multipliers.

(4) Corruption

A system of 'budget sharing' and payoffs is rooted in the implementation of pukka building projects. Part of the building's budget may be shared between the supervising engineer and the contractor. Consequently, a building with sub-standard materials and mixes is implemented with the shrunken budget. A materials supplier may pay an official to buy his rather than his competitor's product and cut costs buy providing lower quality materials. More opportunities are available to introduce sub-standard materials and disguise sub-standard construction in a pukka building than in a kucha one. The total budget and profit margins being higher, it is more lucrative to do so. For an innovation to be adopted in government practice, its entrepreneur may need influence and money to introduce it. The PCC beams and battens entrepreneur can swap favors and pay officials to specify his type of roof but the small sawmill owner is less likely to be able to do so.

(5) Repair and Maintenance

Mechanisms for repair and maintenance of public, especially community facilities buildings, in rural areas are very poor or non-existent. The Local Government and Rural Development Department engineers acknowledge their not having devised a repair and maintenance mechanism yet. A 1981 survey showed that the majority of primary schools were in a bad state of disrepair.

Officials therefore argue that buildings should be 'pukka' and maintenance free. On the contrary, evidence exists that in fact, due to sub-standard construction, many pukka buildings soon need repair and the cost and complexity is such that the local community cannot undertake it while the sponsoring agency delays implementing it.

(6) Lack of Coordination Between Sectors

Approximately 10 agencies are involved in funding and implementing building construction at the district level. Responsibility for materials industries are likewise divided as noted earlier. Coordination of all these agencies would be difficult for a program that attempts to integrate the building activities of all these agencies and building construction with materials industries.

Because of a combination of the above reasons, even ardent advocates of low cost technologies and materials who have occupied influential positions in the government service continue to be unsuccessful in having their ideas accepted into government practice. Of the two former directors of the Building Research Station (both authors of several technical papers and experiments on the subject), one subsequently became a member of the Technical Board, Planning and Development Deprtment (the main funding agency) and the other headed the Communication & Works Department (the largest construction execution agency). To explain their failure, one cites the 'generalists', i.e., the administrators and finance officials who blocked his ideas; the other identifies the general 'rigidity of the system'.

Innovations exclusively from within the government system would appear difficult. To illustrate, a former head of the Appropriate Technology Cell in the federal government turned private consultant now successfully introduces his ideas in government projects. An early version of the PCC beams, battens and tiles roofing was developed before this was introduced by private entrepreneurs. For 6 years, the member of the Planning and Development Department Technical Board unsuccessfully tried to interest the government in an industrial lime-burning plant to produce lime as a cement substititute. Recently, a private entrepreneur offered to take up the scheme.

However, the urban based private entrepreneur will not, at least initially, be interested in innovations that rely on developing informal and (to him) little understood production and supply networks and technologies the markets of which are initially also at the lower, informal and relatively unlucrative sector of the society. He cannot be expected to respond to arguments of social benefits such as providing affordable shelter to the lower income groups and generating employment.

An external agency with independent funding and sufficient credibility is required as a catalyst to at least initially perform the following functions:

(1) Demonstrate clearly the technical and economic feasibility of a program promoting certain technologies and materials industries as part of the rural development effort.

(2) Help set new standards on what technologies and industries are acceptable in a modernising society.

(3) Be welfare motivated but nevertheless capable of mustering both technological and business talents to test and demonstrate the proposed innnovations.

(4) Elicit the cooperation and coordination between different government sectors.

(5) Work closely with at least 1 or 2 government agencies so that the issue of institutionalising the innovations can be addressed from the outset.

(6) Mediate between government and a wary private informal sector.

How abt purely economic decisions?

6. A Program for Rural Building COnstruction

A program which combines the development of key building materials industries with the adoption of appropriate building technologies would need to be implemented since materials industries and technologies are interlinked in a demand and supply relationship. Initially, such a program could be formulated for 1 or 2 rural districts to test and demonstrate the feasibility of the approach before expanding the program to formulate a national policy and strategy.

6.1 Materials Production

The following materials industries should be promoted;

6.1.1 Sun-baked Bricks ("Stabilised Solar" Bricks?)

A large number of the rural population earn their living producing sun-baked bricks and live in sun-baked brick houses. The basic skill and the material inputs are widespread. What is required is the introduction of a technology to improve the quality of the bricks and the management of their production and supply, in an organised manner. The technology exists in the manual brick presses and additives such as lime and soil cement to improve weather resistance. Given a technology that they already have basic expertise in, one they can afford to adopt and 1 or 2 success stories, sun-baked brick makers can be encouraged to form small industrial cooperatives producing the bricks. A precedent of this exists in the agriculture waste fired (wall) kiln coops formed by the former trench kiln workers (see case stuies).

616.2 Wall Kiln Bricks (Agricultural Waste fired)

For the fired brick market, wall kiln bricks using agricultural waste as fuel could produce low cost bricks while maximising rural multipliers, and having a technology and capital requirements acceptable to lower income entrepreneurs. Being able to widen and narrow the wall to decrease or increase the volume of production as firing proceeds is particularly useful to entrepreneurs whose financing of production is closely dependent on current and fluctuating sales

6.1.3 Timber

Tree farming of fast growing trees and a construction timber industry, providing a regular supply of well treated and cured beams, battens and boards to owner-builders and the goverment would find a market in kucha housing as well as in pukka housing dwellers and domestic scale public buildings. Accacia Arabica (kikar), the most widely growna and used tree in Sahiwal, matures in 15-20 years, re requires little care and investment, grows well in saline and marginal lands and, once matured, offers a more profitable mix of construction timber, wood fuel and a number of other uses as than when cut at a younger age primarily for fuel. Other faster growing trees (.eg. Eucalyptus, 5-10 years) are being successfully introduced in other areas of Pakistan. Curing techniques are a trade-off between the time and cost but neither is so large as to be insupportable in a rural economy and the pace of building within it.

6.61.4 Lime

Lime kilns, like brick ones, can be organised as small-scale industries within a rural economy. THey can also be fired using agricultural waste. Lime, substituting for cement can significantly reduce cost and increase rural multipliers. Limestone, however, is mined outside the district. The economics of trucking it in as opposed to purchasing processed lime from outside, needs to be examined. A neighboring district has a lime industry which trucks in the limestone, suggesting the feasibility of this approach.

6.1.5 Summary

Manual pressed sun-brick, agricultural waste fired bricks, timber and lime are a set of industries that would meet the majority of the material inputs required for rural buildings, at a much lower cost than their current alternatives. At the same time these are industries with capital, technology, input and market sources suitable for the rural areas. If promoted they could not only significantly reduce rural construction costs but also increase rural income and employment.

6.2 Building Technologies

A range of building technology options are required which are responsive to changes in incomes, expectations and uses.

A basic set of these technologies are proposed based on the concept of minimum acceptable and affordable needs rather than the maximum.

(1) Kucha technology with minimum upgrading required to combat the technologies' most recurring shortcomings in weather and termite resistance. Simple improvements are proposed such as using fired or stabilised bricks where walls are most vulnerable to moisture, and treating timber where they are most vulnerable to termites. The promotion of this technology would be aimed at the middle to upper income rungs in the kucha housing market and possibly the lowest rung in the kucha-pukka market who would not spend on upgrading kucha-pukka if a cheaper alternative presented itself. Government buildings such as primary schools, union council offices and housing for the lowest grade government employees could adopt this technology (see proposed technology #1).

(2) KUcha-pukka technology using 'Ghilafi' walls, well cured and treated timber beams, battens and boarding, the latter replacing clay tiles. This technology would be aimed at the middle income groups and those at the lowest rung of the upper income groups. Government builings such as secondary schools, health centres, markaz council offices and housing for the middle-grade employees could adopt this technology.

(3) Pukka housing using wall kiln fired bricks in lime mortar, steel

beams, battens and clay tiled or fired brick vaulted roofs. This technology could be adopted by the upper income groups and also in larger government buildings such as District COuncil offices and housing for higher-grade government employees.

6.3 Implementation

A rural building program at the district level could be mounted over a 3-5 year period to give sufficient time to test, develop and demonstrate the effectiveness of proposed technologoes and industries.

From an analysis of the number of public buildings to be funded and constructed over that period, and by allocating them according to the technology to be adopted, the material input requirements for that period could be assessed. The demand therefore markets for their outputs thus insured, the number, type and capacity of the pilot materials' industries that could be started would be known, (see Fig. for example of the number and disribution of building types according to technology and their material demand requirements using building construction figures for 1978-83.)

To the extent possible, the pilot industries would be joint ventures with private entrepreneurs already producing the materials. The entrepreneurs would be insured a market for their products and a share in increased profits provided they cooperated in improving production technology and management as suggested by the program. Thus materials could become more easily available rather than having to await the start up and production of new industries, and improved methods would be quickly disseminated among local entrepreneurs. Over the 3-5 year period the program agency would reduce funding and technical support for the industries at a pace in tune with the entrepreneurs' capacity to independently finance and operate the industries along the improved lines. A schedule for recovering the program's investment in these industries could be devised ~~over this~~

over this period from a share of the industries' profits.

The building construction program should be set up to incorporate training in the technology and management of such projects for local masons, councillors and community representatives, and local government engineering and management staff. A particualar aspect of this training would be to teach methods to assess what community resources/participation could be drawn upon and how they could be organised to not only support initial construction but also take responsibility for repair and maintenance. Since the match between community resources, contributions, input demands and repair and maintenance patterns have been established for each technology the system for communitv participatiom could more easily be devised. The training program could be centered around the construction of a selected number of building projects and implemented as 'learning by doing' workshops.

The entire building program -- materials industries development and building construction-- could be used to train district planners and technical staff in the broader issues and techniques related to the development of rural industries and the meeting of building and physical infrastructure requirements.

6.4 Institutional Framework

The Local Government and Rural Development Department should first demonstrate the effectiveness of the approach within its building programs before other sectors are invited to adopt similar approaches or act in a coordinated manner. The deprtment, more than any of the rest, combines in its mandate a concern with rural development issues such as employment generation and community participation with construction. It is also increasingly given the responsibility to implement the building projects of other sectors such as Health and Education.

However, to break through the 'system rigidity' of the bureaucracy to make such a novel approach to building construction acceptable, even at the level of a pilot program for one department, an external catalyst in the form of a credible multilateral agency or NGO is required to initiate the program. Thus such an agency proposes the building program either as an independent one or as part of a larger integrated development effort in a rural district. The agency offers major funding and invites the Local Gov't. and Rural Development Department to participate with its construction budget, programs and staff.

7.1 Applications to Infrastructure COnstruction

The approach outlined in this study for building technologies could relatively easily be applied to other basic physical infrastructure requirements of rural areas such as feeder roads, particularly road soling, culverts, irrigation and settlement drainage channels and lane paving. The technologies, material and labour inputs for the construction of such infrastructure could be identified in the same manner as was done for this study along with their differential effects on income and employment, costs, coverage and complexity. Since fired bricks, aggregate and cement (or lime substitute) are major material inputs for infrastructure construction, the calculations done in this study for the related industries would directly apply to infrastructure construction as well.

Often the same government agencies -- Buildings department, Local Government and Rural Development, etc., and the same technical and managerial resources in the form of masons, government engineers, councillors and community representatives are called upon to implement such programs. Thus the analysis and findings on the institutional and human resource aspects of this study would apply in large part to infrastructure construction as well. It follows that basic rural buildings, physical infrastructure and supporting materials industries development should be implemented as one development program. Only time limitations did not permit infrastructure to be included in this study. Certainly a much more substantial impact on rural incomes and employment and on demand for rural industries would result from redirecting the effects of both building and infrastructure construction towards maximising the use of rural resources.

7.2 Impact on Coverage, Income and Employment

Impact has been assesed in 2 different ways: relative and absolute.

Relative impact has been assessed by comparing the increase in coverage and rural income and employment achieved by switching public building form the present pukka technologoies to the largely kucha and kucha-pukka technologies proposed here. The coefficient of each technology for local multipliers, receipts to lower income groups, employment generated and covered area achievable have been applied to the public building construction budgets at the district level and for settlements less than 25000 population. The increase in each of these aspects -- income and employment and coverage was found to be substantial (for example, see page). The increase in demand for the products of rural industries was also found to be substantial.

To assess absolute impact, the increases were then compared to the total building and employment needs of the district. The impact on absolute requirements were found not to be substantial. Clearly, far more than the technology choice in building construction will need to be acted upon if absolute requirements are to be met.

If private building construction, particularly in the larger t towns Sahiwal, Ariffwala and Pakpattan also adopt these technologies t then there should be a greater impact on absolute requirements. Similarly, if the effect of basic physical infrastructure is included as suggested in the preceding section this would further increase the impact on absolute requirements.

Technology choice may not be the primary instrument in meeting rural building needs and building construction may not be the leading sector in raising rural incomes and employment, without substantially increasing total funding for construction. However, given the correct mix of technologies, materials industries and construction, far more could be achieved for the rural areas with the same level of funding and human resources. A construction program designed to take technology choice and its effect on income and employment generation, complexity, costs and coverage into account, plays an essential hitherto neglected, role in rural developemnt.