CHAPTER FOUR

INDIGENOUS VERSUS IMPORT-INTENSIVE TECHNOLOGIES: EVIDENCE FROM SAHIWAL

In this chapter we examine the imnportance of technology choice. Is there really a significant advantage in adopting indigenous rather than import-intensive technologies in construction and materials production projects? 1

To address this question we compare the alternative technologies against three sets of criteria: first those criteria of equity and efficiency;2 second in terms of who gains and who loses from the current shift to import-intensive technologies and finally the effect of the alternatives on the objectives of promoting participation and local institutions.

4.1 The Equity-Efficiency Trade-off: Assumptions and Evidence.

We address the above etc [asin text]

[put below as conclusion]

4.4 In Sum.

In sum what do the preceding findings suggest especially in terms of the issues raised and the positions taken by the alternative development perspectives that we presented in chapter two.

The potential for a trade-off in efficiency atleast in the short run to achieve equity objectives was implicitly acknowledged even in the position of the advocates of indigenous technologies. The achievement of short-run equity objectives is the most that supporters of import-intensive technologies from the development theorists to local engineers are willing to concede. The greater efficiency of import-intensive technologies is accepted by such persons almost as an act of faith; much in the same way that the greater equity advantages of indigenous technologies are accepted by the supporters of such technologies.

1/ Our construction technology examples are sun-brick walls and timber roofs compared to fired brick walls and reinforced concrete roofs. Our production technology examples are brick kilns; wall type, agri-waste fired kilns compared to oval trench type, coal and oil fired kilns.

2/ [include criteria definitions here as in original]

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Chapter ~~3~~ 4
Indigenous versus Imported Technologies:
Assumptions and Evidence

It was clear from the last chapter that Pakistan's policies stress district development including physical improvements - infrastructure, community facilities and housing - at that level. Employment, income distribution and community participation are also prevailing objectives of the government.

We also found that up to 40 percent of development expenditures in the Punjab province are on construction; 20 percent, on building construction alone. Thus if the cost-effectiveness, employment and income distribution impacts of construction investment vary significantly with the technology adopted and if the technologies currently favoured by government are weak in these ~~regard~~ respects, the finding is important given the scale of public investment involved. A shift to the more appropriate technologies would more effectively utilise a large share of public investment in promoting Pakistan's development objectives.

We previously discussed three types of usual explanations offered for choices made among alternative technologies. These three are: an equity versus efficiency trade-off, vested interest with the more powerful influencing choices, and finally a mix of social and institutional reasons.

Therefore, the following analysis of the alternative technologies is structured such that we can examine whether there are significant differences among these technologies relative to costs, employment and income effects while also testing the validity of the explanations related to equity-efficiency tradeoffs and vested interest.[1] We first compare the performance of alternative building construction and materials production technologies against equity and efficiency criteria.[2] We then identify gainers and losers from the current trend of using imported technologies to see which interests are served and what the finding suggests about how these interests may influence technology choice.

1/ We leave for the next chapter the discussion on community participation and the explanations dealing with socio-institutional factors.

2/ The equity criteria for both construction and production technologies are as follows: low-cost (affordability), employment, and income distribution, especially within the district and among the rural and low-income groups.

Note that two measures of income distribution are used: from the undiscounted cash flow analysis and from the cost-benefit analysis. The differences between the two and the rationale for using both are discussed in the methodology section.

For the construction analysis the efficiency criteria are as follows:(a) cost-effectiveness - initial construction and maintenance costs discounted over the building's life span; (b) economic costs of construction, and (c) capital and labour productivity. For the production analysis the corresponding criteria are: (a)cost minimisation; (b) profitability, financial and economic, and (c) capital and labour productivity.

Savings effects come under efficiency criteria for both construction and production technologies as recorded from the cash flow and cost-benefit analysis (see Figure 1 for detailed list and description of the criteria against which technologies are compared).

A. Indigenous Versus Imported Technologies: Equity Versus Efficiency?

We address the above question by focussing on common assumptions about the relative performance of indigenous and imported technologies and by examining what our empirical evidence suggest about the validity of these assumptions.

Assumption One. Indigenous construction technologies may be cheaper than imported technologies but they are not significantly so, especially if we take economic costs into account.

Using market prices, we find that the imported construction technology is about five times more expensive than the indigenous alternative (Rs. 18 per square foot compared to Rs. 85 per square foot respectively)[3]. Or for the same investment, almost five times as much shelter space can be provided by the indigenous technology than by the imported one.[4]

3/ These and the following maintenance costs do not include contractor's overheads and profits. Inclusion does not alter the ratio between the costs of the two technologies.

4/ For construction, all values are expressed in Rupees (Rs.) per Rupees 100 of construction expenditures or as Rupees per square foot of sheltered space. For production, all values are stated in rupees per rupees 100 of brick purchases (i.e., the receipts from brick sales or the value of output) or Rupees per 1000 bricks. In both cases, the per Rupees 100 represents in effect the unit of investment in the district that occurs through construction expenditures. Where the values are Rupees per Rupees 100 they can also be expressed as percent of investment.

Accounting for economic costs, we can expect the difference to be greatly reduced in favour of the imported technology, which uses a higher proportion of such heavily taxed inputs as cement and steel. The difference, however, is only slightly reduced (by 2 percent) because the market wage rate for unskilled labour is also higher than the economic wage rate. Since the indigenous technology uses a much higher proportion of unskilled labour than the imported one, the differential in cement and steel costs is thus offset (see Figure 4; for the underlying costing, financial and economic analysis see the Construction Model Figure I, specifically 4.1 and 4.2). A full discussion on cost-benefit techniques, the selection of the shadow prices and their implications on the evaluation of the alternative technologies is given in Chapter two.

Assumption 2. Indigenous shelter technologies may have lower initial construction costs but their much higher maintenance results in greater costs incurred over the building's life - span.

This assumption, expressed as cost-effectiveness over the building's life-span, is commonly made by government engineers in the public works departments (for the same assertions made in other countries and projects, see Tendler, 1978:   ).

Precise maintenance patterns are difficult to establish. From case-studies and interviews with builders and engineers a worst case pattern for the indigenous technology and a best case pattern for the imported technology is adopted.

According to these patterns, over a twenty year life-cycle, the indigenous technology requires annual re-rendering and major structural repair every ten years, which amounts to reconstructing the building over the twenty year period. The imported technology requires some re-rendering every five years and minor structural repair every ten to twenty years (compare Figures I.2.1 and 2.2).

Once maintenance is added to the initial construction costs, undiscounted, construction using indigenous technology costs 60 percent of the one using imported technology. Applying a 20 percent discount rate (a low figure given capital scarcity in Pakistan and typical rural interest rates of 25 - 100 percent), the cost of indigenous technology drops further to only 30 percent of the imported alternative (Figure 4). Therefore, even with worst-case maintenance scenarios and at conservative discount rates, the indigenous technology is far more cost-effective than the imported one throughout the building's life span.

The equity advantages of indigenous technology are more apparent when we consider the income flows from maintenance expenditures. The maintenance of indigenous technology is more labour intensive compared to the construction stage, and it is more unskilled labour intensive compared to the maintenance of imported technology. The share of on-site labour income to total construction expenditures on indigenous technology increases from 45 percent during initial construction to 74 percent during maintenance; the same figures for imported technology are 24 to 35 percent respectively. This increase in income is equally shared by both skilled and unskilled labour in the indigenous technology, but in the imported technology, skilled labour gets most of the increase (see Figure 4).

Other implications of the technologies' contrasting maintenance characteristics on such institutional factors as community participation and the appropriate implementing agencies will be discussed in a later section.

Assumption Three. *The local income and employment generating effects of expenditures on indigenous technologies are not much greater than those on imported technologies especially if we take into account leakages through respending on ~~[illegible]~~ the inpots of materials production and supply.*

3.1 Comparing Construction Technologies

After respending leakages (i.e., second-round payments) have been traced, 98 percent of the expenditures on construction using indigenous technology still remain within the district to generate local on and off-site incomes and employment. In contrast, 46 percent of the expenditures on imported technology are leaked out of the district through payments for imported materials such as cement, steel and coal (used to fire bricks). The leakage of 2 percent in indigenous technology results from the purchase of reeds for roof mats from the neighbouring district - a major reed and mat producing area (see Figures I, 3.1 and 3.2 for the underlying cash flow analysis giving these results).

Every Rs. 100 of expenditures in indigenous construction creates approximately 2.1 man-days of <u>on site</u> employment, of which 1.5 man-days are in unskilled labour. The comparable figures for the imported technology are 0.72 man-days, of which only half a manday is in unskilled labour. The indigenous construction technology is more labour, as opposed to materials intensive, and uses more unskilled labour than the imported technology. (Please refer to Figures I, 3.1 and 2, Box IC for the underlying analysis.)

After leakage through respending on the inputs of materials production and supply is accounted for, Rs. 100 in indigenous construction generates approximately 3.2 man-days of local on- and off-site employment in construction <u>and</u> materials production and supply. The same expenditure in imported construction technology generates only 1.67 man-days.[5]

3.2 Comparing Production Technologies

Ninety percent of the receipts in the indigenous wall type brick kilns remain in the district to generate local income and employment as compared to only 43 percent in the trench type kilns (Figure II, 1.1 and 1.2).

Although inputs for the indigenous kiln are entirely local, charges for transporting the bulky agri-waste are high; hence, the 10 percent leakage from the second round of payments made by the truckers for diesel fuel. In trench kilns, 57 percent of the receipts immediately leave the district as payments to the producers, dealers and truckers of the coal and oil used in these kilns. These recipients are all based outside the district.

5/ The on- and off-site employment figures are obtained by dividing the cash flow remaining within the district (which is Rs. 97 for the indigenous technology and Rs. 49 for the imported technology) with a wage of Rs. 30 per man-day.

This average wage rate is derived as follows:

In building construction the typical ratio of skilled to unskilled workers is 2:4 and the ratio of earnings per day is Rs.20:Rs.50 respectively. The weighted average is therefore Rs.30 per man-day. Wage rates are similar in brick production and supply, but the ratio of skilled to unskilled workers is 1:6. The weighted average wage in this case is Rs. 25 per day. However, we adopt the higher figure (Rs. 30) to estimate the employment effects of this wage income. A higher figure gives a lower employment rate and roughly compensates for the slightly overstated wage bill that results from the inclusion of the entrepreneur's profit in the total wage bill.

As for employment 3 man-days are created in the district for every Rs. 100 of brick purchases from the wall kiln as compared to only 1.4 man-days created in the trench kiln. However, on-site employment is higher in the latter kiln as we shall discuss below.

Assumption Four. *Indigenous technologies may be more equitable in terms of their local employment and income effects, but imported technologies are more efficient in their use of inputs per unit output as reflected in lower production costs, higher productivity and profitability (financial and economic).*

The debate around equity versus efficiency and employment versus output is a central and an ongoing one in the development literature. Pakistani government officials also cite efficiency as the reason for favouring the most modern construction and production technologies.

4.1. Comparing Construction Technologies

The greater cost-effectiveness, that is lower production costs, of the indigenous construction technology has been discussed under assumptions one and two above. For the same cost, using indigenous technology can create approximately five times more shelter than imported technology.

Labour productivity is also higher in the indigenous construction method: 0.4 man-days is required to produce a square foot of shelter space as against 0.6 man-days when using the imported construction technology (see Figures I, 3.1 and 3.2, Box IC). The extra labour in the latter technology is required for the higher standard of construction as in surface rendering and pointing of mortar joints rather than for producing more sheltered space.[6] Thus the indigenous construction technology is more efficient in its use of capital and labour while also providing more employment per unit of expenditure, i.e. per unit of investment.

4.2 Comparing Production Technologies

The results from a comparison of the brick production technologies are, however, contrary to those expected. The imported technology using the more modern production methods - the trench type, coal-fired kiln- provides slightly more employment but is much less efficient than the indigenous wall type, agri-waste-fired kiln . Per Rs.100 output, the trench kiln provides 1.6 man-days of employment; the wall kilns, 1.5 man-days. On the other hand, the production cost per Rs. 100 of output for the trench kiln bricks is Rs.97 as

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6/ It can be argued that, because the two products are not of equal quality, cost and labour productivity comparisons bias unfairly against the higher quality product. Differences in quality with regard to cost comparisons are corrected for by taking maintenance costs into account. The corrections are less satisfactory for productivity comparisons. Along with other exponents of basic needs, we argue, however, that since the objective is to provide basic shelter, differences in quality need not be considered beyond those spatially and structurally essential. Differences beyond essentials are considered when they are relevant to the issues being addressed like when income from rental or resale, or value attached through cultural or taste preferences are being discussed.

compared to Rs.85 for the wall kiln bricks. The financial profit margins are therefore much smaller for the trench kilns (see Figures II, 2.1 and 2.2 Box IA).

Adjustments for economic costs hardly make a difference to the relative production costs and profits. The downward adjustment in labour costs is almost equal in both production methods. The extra tax on diesel paid by the more transport intensive trench kiln is offset by the subsidy on the coal it uses. For both kilns then the economic analysis shows a larger social than financial profit but their positions relative to each other remain ~~s~~ unchanged. (Figure II, 2.1 and 2.2).

There are three reasons why, contrary to expectations, the trench kiln is the more labour intensive while being less efficient.

First, fuel is the major cost factor for both kilns, and agri-waste is much cheaper than coal and furnace oil.

Second, the larger scale of the trench kiln and the loan-indentured labour system it uses adds to its labour costs.[7] The kiln requires a much larger area of clay land

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7/ Under the loan - labour (paish-gi) system, the worker is given a loan on joining a kiln. Repayments are deducted from his future pay. The majority of unskilled workers in trench kilns, especially brick moulders, work under this system. For the rural poor who live at subsistence and are easily in debt, this system offers immediate relief. For the kiln owner, the workers' effectively indentured status guarantees a continuing supply of labour, and as we shall see, at subsistence rates.

than is required by the wall kilns. This land, where bricks are moulded, can be some distance from the kiln site. The costs of brick loading, unloading and carriage - an animal and labour intensive activity - are higher than in the wall kilns. Paid managers are also designated from among the 30 to 60 brick moulders (most of whom would have loans owing to the kiln owners) to insure both a steady supply of bricks and that no one absconds before his loan is repaid.

Finally, to insure their presence till the next production season, the brick-moulders continue to be paid during the 2 to 4 months annually when the kiln closes due to rains.

The wall kilns, being smaller, avoid both the large transport and management costs. The fewer moulders are paid higher rates but are not kept on when the kiln is closed.

The kiln wall can be also widened or narrowed to increase or decrease capacity in response to fluctuations in supply of moulded bricks or in demand by buyers. In the trench kiln, the wide trench walls are fixed. A slowing down of either the supply of moulded bricks or of demand, usually requires stopping the firing process. Subsequent refiring start ups add to fuel costs.

A combination of economic, institutional and technical reasons explain why the wall kilns are a more efficient production method, but the single most important factor here, as mentioned, is the cheaper fuel: the locally obtained agri-waste compared to the imported coal and furnace oil.

Assumption Five. Greater efficiency results in lower production costs and therefore higher profits to the entrepreneur who therefore favours the more efficient imported technologies over the indigenous ones.

If, as discussed, the indigenous wall kilns rather than the imported trench kilns are more efficient and profitable, why are the latter still widely used by the big entrepreneurs? The reasons are threefold.

First, agri-waste fired bricks are considered technically substandard; its use, illegal under the building code. To serve the urban upper-income groups and the government who constitute the bulk of the brick market, the entrepreneurs have to therefore use the coal fired trench kilns.[8]

Second, although theoretically these trench kilns have small profit margins, in practice, these margins are much wider. Timber and agri-waste are often combined with coal and oil to fire these kilns. Under the guise of deducting

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8/ No technical studies have been done to assess the structural qualities of agri-waste-fired bricks relative to coal- fired ones. The former type is used widely in the small towns and villages by all but the wealthiest and the government. Local builders consider it marginally weaker than the coal- fired bricks. That differences in production costs between agri-waste and coal fired bricks are much wider than the differences in sale price suggests that the former type is not considered greatly inferior.

loan repayments, kiln owners in effect pay moulders subsistence rates: a quarter to a third less than the rate kiln owners say they pay the moulders and on which the financial analysis done here is based.[9] For these reasons the preceding analysis overstates the actual production costs of the trench kiln bricks.[10]

Nonetheless, the financial advantages of the wall kilns are perceived by the larger entrepreneurs. Although the wall kiln was introduced from Sind province only a few years ago by small entrepreneurs who operate most such kilns in

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9/ Brick moulders at several kilns complained of being thus underpaid. Responding to complaints made by workers and other researchers, the government passed a law requiring kiln owners to issue notebooks recording payments made to the workers. It is doubtful if this measure will insure full payment because most moulders are illiterate, and the occasional government inspector is easily bribed into accepting the entries made by the kiln owners. The notebooks shown to me recorded Rs.300 to 400 paid out per month, whereas workers produce about Rs. 600 worth of bricks per month.

Whether these subsistence rates represent the shadow wage rate depends on the moulders' awareness that that is what they are being paid and on the freedom the loan-indentured labour system allows them to change their place of work. The evidence suggests both information and mobility are restricted.

The practice of underpayment through the loan-labour system, the restrictions it imposes on labour mobility, and the practice of kiln-owners forcibly keeping workers from leaving the kiln have been documented by other researchers (1978:).

10/ Thus caught between unrealistic building codes and price controls on the one hand and rising production costs on the other, the entrepreneur resorts to illegal and exploitative practices to preserve his profit margins. A similar cause and effect is manifested in the sub-standard construction practices of the building contractor.

the district, bigger versions owned by wealthier entrepreneurs have begun to appear. A contributing factor may be that, despite the building codes, private sector demand for the cheaper wall kiln bricks is increasing, making it worthwhile for the entrepreneur to risk losing the government market. Or entrepreneurs who own more than one kiln may be diversifying.

Whatever the case, efficiency and profitability (financial and economic) seem to lie with the indigenous kiln, which at the same time appears preferable for the equity objectives of employment and income distribution.

Assumption Six. *Investment in income distributing indigenous technologies will be at the expense of national savings and future investment since upper-income groups and the government have a higher propensity to save and reinvest than the lower-income groups.*

Welfare economists and those in favour of housing investment have usually argued their case on the basis of enhancing the productivity of the poor or stimulating further investment through housing (see for example, Grebler and Burns, , Koenigsberger,). Some have questioned whether the upper-income or the government actually reinvest or indulge in conspicuous consumption.

Here, for technology alternatives a different issue emerges: if there are substantial savings in construction expenditures from using the cheaper indigenous technologies, do these savings offset any negative impacts on savings from the income distribution effects?

Both the cash flow and cost-benefit methods of measuring income distribution show that once we include the losses incurred in construction expenditures by switching from indigenous to imported technologies, these losses more than offset the positive savings effects of the extra income accruing to the government and upper-income groups from such a switch. That is, if, as is the case here, we are assuming the projects are government financed.

Let us first take the cash-flow analysis. A shift from the indigenous to imported technology results in a positive impact on savings of roughly 4 percent of construction expenditures. However, once the effects of higher construction costs are included, this positive impact becomes a <u>negative</u> impact on savings of about 11 percent (see Figure I, 5.1., Boxes A,B and D).

Similarly, in the cost-benefit analysis, the small 0.38 percent positive impact becomes a 15 percent <u>negative</u> impact (see Figure I, 5.2, Boxes A,B and D). The small net effect on savings of income distribution is because the government as building financier is paying out to the government which levies taxes on materials.

The above assumes that low-income groups do not save while the upper-income, business and government sectors have saving propensities of 10, 15 and 20 percent respectively. Because the government incurs both the major loss and gain – paying and receiving taxes for materials purchases – changing its savings propensities will have no effect. (The payer and receiver split, however, into the local and central government respectively, the implications of which we shall discuss in the gainer and loser analysis below.)

7. In Conclusion

In sum, the indigenous technologies are both more efficient and equitable. The indigenous construction technology is more cost-effective, even with its higher maintenance costs included. Labour productivity per square foot of sheltered space created is also higher in the indigenous technology. As for production technologies, the indigenous wall kiln, is likewise more efficient, has lower production costs per brick, and offers higher financial and economic returns relative to the imported trench kilns.

Expenditures on construction using indigenous technology and on brick puchases from the indigenous agri-waste kilns create much more local incomes and employment than similar expenditures on the alternative imported technologies.

The lone deviation from the foregoing findings is that the trench kiln provides slightly more employment. But once actual, rather than stated, wages are considered, we see that employment is at lower wages and the share of wage income in the trench kiln is in fact lower than in the indigenous wall kiln.

Finally, the negative impact of income distribution on savings is offset by the substantial construction savings accruing from using the less expensive indigenous technologies.

While the equity advantages of the indigenous technologies could be expected, the magnitude of the difference between the indigenous and imported alternatives, as made evident here, is less well known. The findings on efficiency - productivity, profitability and savings - directly contradict the conventional wisdom about the superiority of imported technologies. These findings suggest that the large proportion of development expenditures on the imported construction technologies could be far more effectively utilised through construction using the indigenous alternatives.

If indeed greater efficiency considerations influence technology choice, the support for imported technologies may, at least in the instances we examined, be based on misconceptions of where the efficiency advantages lie. There is some evidence that institutional and social influences, such as the preferences of government and upper-income groups, reinforced by such factors as building codes override pure efficiency and equity considerations. These influences will later be discussed more fully.

B. Gainers and Losers

1. ~~Int~~troduction

The gainers and losers from the alternative technology choices were implicit in the preceding analysis. Here we identify who they are, the social groups they represent, and the magnitude and spatial distribution of their gains and losses. This information gives us additional criteria for selecting among alternative technologies and for anticipating who will support or oppose particular choices.

If the elite benefit from the current trend toward imported technologies, this finding would corroborate the radical view that vested interest and power relations are important determinants of technology choice.

It is commonly assumed that urban, and upper income groups gain from and therefore support imported technologies, while rural and lower -income groups gain from and support indigenous technologies. The polarisation of interests around these alternative technologies may appear correct from a quick interpretation of the preceding section. However, a closer analysis reveals another clustering of gainers and losers.

The net effects on income (referred to as net income effects in the rest of this section) of switching from indigenous to imported technologies offers us a useful way to identify these gainers and losers. We examine these net effects, as reflected in the cash flow and cost-benefit analyses, first, for the construction and then for the production technologies .

2. Construction Technologies: Sun-Brick Walls and Timber Roof versus Fired Brick Walls and Reinforced Concrete Roof.(Figure I, 5.1; for underlying analysis compare Figures I,3.1 and 3.2)

As expected, the main gainers from a shift to imported technologies are outside the district. The district as a whole loses substantially from this shift. The gainers are those who obtain the largest share of the expenditures on materials such as cement and steel, namely: the producers, transporters and large retailers of these materials based in the provincial capital, Lahore, or in the production sources. The central government may also perceive itself as a gainer if it only considers the taxes it receives on these materials. These tax gains are more than offset by the financial and economic losses the government sustains by adopting the more expensive and inefficient imported technology. (See Fig. I. 5.2 A and B)

Set against these gainers are the losses of almost all groups within the district. This loss is the substantial 44 percent <u>net increase</u> in leakage of construction investment resulting from the shift to imported technology. The expected conflict of interest within the district between the urban and upper-income groups, and the local government on one side, and the rural and lower-income groups on the other is not quite as expected. For reasons of economic gain, most of these groups should support a shift to the more indigenous technologies as indeed should the central government.

The district's urban materials merchants, the local retailers of the imported materials, do not gain as much as expected because local markups are small. The gains in urban income from the retail trade are further offset by the income losses of the urban reed mat makers and construction workers adversely affected by the switch. The <u>net</u> benefits to the urban areas are small: the main gainers here being the urban building contractors. (Fig. 6 for income gains & losses among input suppliers)

The district's rural economy loses substantially. Besides the expected losses to rural contractors and construction workers, much of the loss is borne by the rural elite. The elite would otherwise profit from investment in indigenous construction technologies through the sale of trees for roofing, and of clay, water and sand, which make up a large portion of sun-brick costs. Rural contractor-builders who cannot handle imported technology projects, lose bids to the urban contractors.

Local government revenues are also lost. The revenues from taxes on local manufacturing enterprises like timber mills are higher than those from local retailers of externally produced materials and the octroi taxes from bringing the materials into the district (for example, compare the local tax obtained from the timber mill, Figure III, 3.1 with that obtained from cement distribution, Figure IV,3).

Thus from the district's viewpoint, there should be no major opposition to the adoption of more indigenous technologies. Given that the rural areas would gain much more than the urban groups would lose in the event of a shift to more indigenous technologies, these areas could (thorough some policy measure) compensate the urban groups for their losses and still maintain substantial gains. The central government should support such a shift if it looks beyond its tax gains to the financial and economic losses it bears by adopting the imported construction technologies.

3. Production Technologies: Wall Type, Agri-waste fired Brick Kiln versus Trench Type, coal fired Brick Kiln.(Figure II, 4.1 , Box A; for underlying analysis compare Figure II, 1.1 and 1.2)

As in construction, likewise in production. The shift to imported technology benefits groups outsiede the district at the expense of those within it. A <u>net increase</u> in leakage of 47 percent of local expenditures on bricks occurs because of a shift from using those produced by the wall kiln to those produced by the trench kiln.

This leakage is an income gain for the coal and oil industries and the coal truckers based outside the district. It is a loss for the district's agri-waste producers - mainly the large wheat and cotton cultivators, ginning factory owners - and the local urban based, truckers who transport agri-waste to the kilns.

Thus the assumption that adopting imported technologies at least benefits the urban and upper-income groups within the district is more erroneous for production than it is for construction. Besides the expected losses for rural areas and lower-income groups, the urban groups within the district - the truckers and their labour - and the upper-income groups in general, the large landowners included, all forego a substantial income gain by the adoption of bricks produced by the trench rather than the wall kilns.

The upper-income groups lose much more than the lower-income groups from the shift. The local elite, represented by the large landowners and the truckers (often the same people) are the single largest losers. The local government also loses revenues. Municipal revenues from taxes paid by the local truckers, in addition to octroi payments made by these firms, are higher than those from octroi alone paid by the oil and coal truckers based outside the district (Figure II, 4.1).

The cost-benefit analysis shows that a shift to the bricks of the trench kiln results in an income gain for the kiln workers and a somewhat larger loss in revenues for the central goverment (Figure II, 4.2). As discussed earlier, the payments to the brick moulders in these kilns are almost certainly overstated. Hence, the workers' recorded income gain may be misleading. The central government loses by the switch because part of the diesel tax it gets from the transport of oil and coal is offset by the subsidies it provides for coal. The wall kiln, on the other hand, uses no subsidised inputs. This loss to the central government is in addition to its losses from paying for the more expensive coal fired bricks for its public construction projects.

Thus the cash flow and cost-benefit analysis reveal that, except for the coal industry and the truckers in the coal producing areas, nobody gains income from the promotion of trench kiln bricks. As discussed earlier, even the kilns' entrepreneurs would make more profits if they switched to wall kilns, and if the government lifted the ban on using agri-waste fired bricks for its projects. There should be a broad constituency of support for the removal of such a restriction, among the low-income groups and the district's elite. Given the effects on revenues, the central government should support such a move.

4. In Conclusion

In sum, the main gainers from the shift to the imported technologies are the producers and suppliers of the inputs for these technologies: the large cement, steel, coal and oil producers, retailers and transporters, all of whom are outside the district. From within the district, only the building contractors gain to a significant degree. Almost everyone else within the district loses. There is evidence that much of the income losses fall on the district's elite including the local government. The central government's gains are ambiguous at best because tax revenues are offset by other losses.

Perhaps the most important finding here is the unexpected convergence of interests of the local elite with the promotion of indigenous technologies. The active support of these elites is essential to the successful implementation of local level projects. Clearly, the benefits of the indigenous technologies to these elite have yet to be demonstrated. The questions then remain: how can these benefits be persuasively demonstrated? Assuming local groups are persuaded, how can these groups influence decisions affecting technology choice when many decisions are made outside the district? Finally, is there a more complex weaving of interests, such as maybe between the government and the cement and steel industries, that determine technology choice but are not captured in the foregoing analysis? These questions will be addressed in the next chapter.