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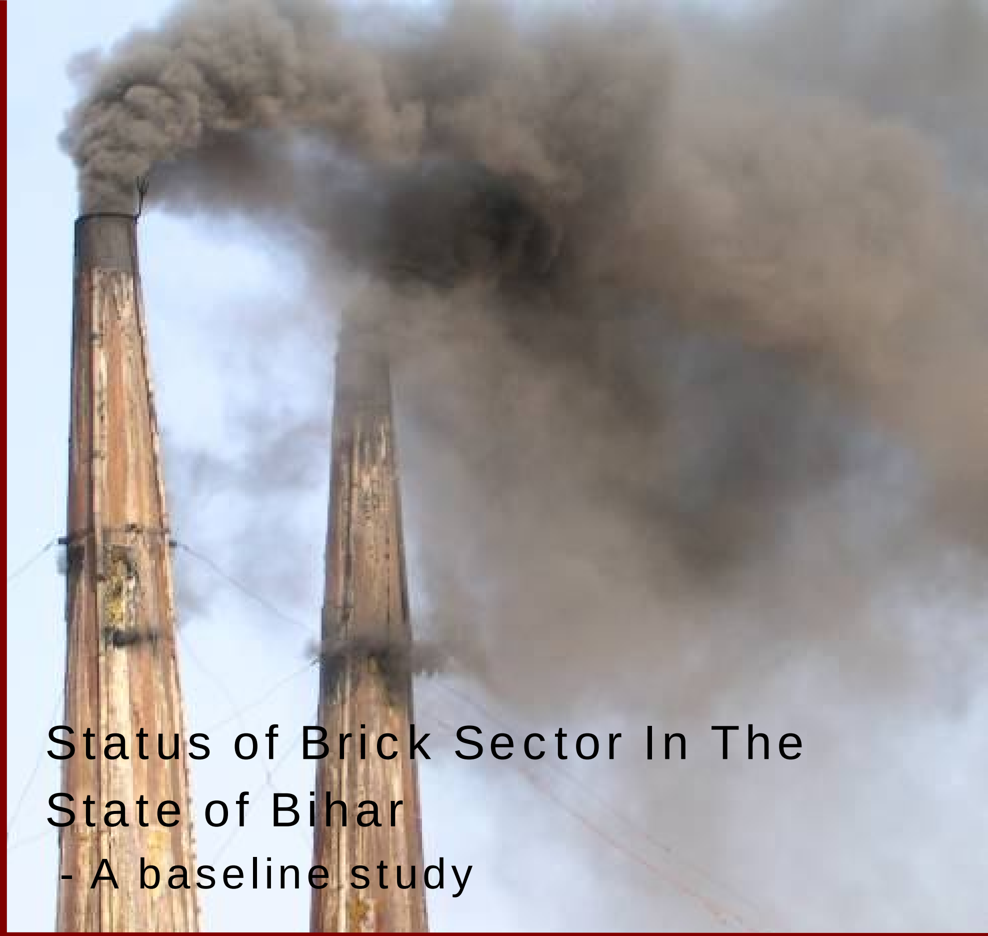

Status of Brick Sector In The State of Bihar
- A baseline study

Development Alternatives

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- A Baseline Study

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Executive Summary

Status:

The state of Bihar is developing rapidly. In the five year period from 2004 to 2009 Bihar's Gross Domestic Product (GDP) has grown by 11.03% and between 2001 and 2011 there has been a significant increase in urbanization with the number of towns increasing from 120 to 213 according to the latest census. This has been possible through investment in various sectors, especially the construction sector. If this growth rate needs to be sustained, the demand for quality building materials will increase manifold. In rural areas too, Bihar faces challenges with the need for over 7.5 billion bricks over the next five years to meet the rural housing gap.

A field study was conducted in 5 districts on Bihar to understand the present scenario of the brick industry and to assess the market potential and barriers for introducing energy efficient technologies for walling materials. The major brick producing districts of Bihar are situated in the Northern and Central part comprising of Patna, Nalanda, Siwan, Muzaffarpur, Sitamarhi, East and West Champaran, Darbhanga, Samastipur and Madhubani. With over 5,700 authorized brick kilns the state produces around 17 billion bricks per year.

The brick sector in Bihar is growing at a rate of 9%, however it continues to be dominated by traditional technology - the Fixed Chimney Bulls Trench Kiln (FCBTK). Unlike the rest of India (except Punjab, Haryana, Uttar Pradesh and West Bengal) the state of Bihar is the only state which has transformed the brick firing technology from movable to fixed chimney. All this has been done through own investment without any technical or financial support from the Government. The FCBTK is comparatively resource and energy intensive as compared to newer technology alternatives. The main fuel used for firing bricks in the Fixed Chimney Kilns is coal. However the use of firewood has also been observed in some instances especially during the initial firing period. Coal consumption is in the range of 20-25 ton/lakh bricks produced and on an average, breakage losses are greater than 10%. However the overall green and fired brick losses are around 30%. This is due to the open nature of the business disrupted due to unseasonal rains especially during the peak summer season.

It was observed that the major raw material used in brick making is soil consuming around 16,500,000m^3 of soil per year. No instances of alternate materials and products were prevalent in Bihar. 90% of the brick making soil is procured from agricultural land with only 10% from river bed. This rampant use of agricultural soil is leading to a loss of around 5,500 acres of fertile agricultural land per year. This land otherwise would have supported the production of 7,000 tons of rice. Thus use of brick making through agricultural soil is making 1,10,000 people suffer due to loss of food grain. Thus this type of uncontrolled soil use will lead to a famine like situation in the near future if alternate methods not adopted accordingly.

One of the major issues in Bihar is the non existence of alternate technology e.g. VSBK, High draught or fly ash. There are some sporadic instances of High draught and VSBK but they are not the choice of most entrepreneurs. This is mainly due to lack of awareness on its existence and demonstrated advantage. Although there are thermal power plants in the state, no commercial fly ash units have come up yet. The major reason is the availability of fly ash from thermal power plants to entrepreneurs. The common answers by the power plant authorities are that there is no demand. On the other hand entrepreneurs complain of lack of raw materials availability. To break the impasse no initiative has yet been taken by the State Government on promoting the same with increased awareness and demonstration of its use on public buildings to create confidence amongst users.

The Bihar brick sector is also characterized by high levels of pollution. Calculations show that the specific energy consumption in fixed chimney kilns is around 1.59 MJ/kg. This leads to a consumption of around 4 million tons of coal responsible for releasing high levels of suspended particulate matter. This amount of coal when burnt in FCBTK technology is also responsible for releasing around 12 million tons of carbon dioxide making it the highest GHG emitter in Bihar in the entire industrial sector.

However the state of the Bihar brick industry is in a state of transformation. With increasing coal prices and depleting profits, entrepreneurs are increasingly looking at ways and means to reduce spiralling energy costs.

Proposed interventions:

Many organizations have been working towards improvement of the existing brick sector in India and Asian countries. Successful initiatives have been launched towards improvement of existing brick production practices. Incremental improvements in green brick making, use of body fuel, better feeding/firing practices and design changes have ensured a substantial reduction in anthropogenic emissions. Energy savings through arrestation /reduction of heat losses have resulted in substantial profitability also. Improved product quality has also increased earnings. Thus it has created a win-win situation for all. Introduction of new technologies have also started, creating a "basket of choices" for an entrepreneur to adopt and practice environment friendly brick making options. Initiatives have already been taken up in introducing new initiatives in Bihar through the introduction of Vertical Shaft Brick Kilns. Response has been slow due to high capital requirement. However improvement of existing technologies has been overlooked till date. It has substantial potential of replication since capital investment is low and does not require **"total transformation"** in the existing practice of brick making and firing.

It is proposed to initiate interventions in improving the existing brick industry in Bihar. A two pronged approach is hereby proposed:

1. Improvement of existing technologies
   In this approach the existing FC BTK technologies will be encouraged to use internal fuel in green brick. This will reduce both external fuel consumption, resulting in energy savings and also improve upon the environmental emissions.

2. Introduction of new technologies
   Sensing improved profitability, there will be new entrepreneurs willing to invest in the brick business. They should be encouraged to adopt new technologies e.g. fly ash block making technology, hollow brick making and Vertical Shaft Brick Kiln

Technological interventions will be based on "Appropriate Technology" and it's "Transfer" building on the indigenous knowledge and skills with the participation of the brick entrepreneurs and the community. A "carrot and stick" approach is proposed involving strong policies and its implementation supported by favourable financial incentives based only on performance.

Recommendations:

- Extensive awareness generation and demonstration of eco friendly brick production technologies.
- Extensive capacity building for workers, and service providers to create a pool of trained manpower to service the brick industry.
- Capacity building of policy makers to create an enabling environment for adoption of environment friendly technologies.
- Brick sector should adopt methods and clean technologies which would lead to improvements in quality and fulfillment of need of good quality construction material market.
- Review of existing policies and formulation of new policies related to energy-resource efficient brick production to create a preferential regime for cleaner brick production technologies.
- State and Central government should give more attention in technology adoption as well as in energy efficient brick production by setting examples in the use of green building materials in public construction.
- Financial institutions should be sensitized to support financial needs of credit worthy brick kiln entrepreneurs. Additionally, other modes of financing other then loans and subsidies need to be considered.
- Steps need to be taken to enhance public awareness on cleaner brick usage; this includes information on various technology choices, details of service providers, financing options and how to avail finance.
- Since there are a number of stakeholders involved to enable a transformation in the brick sector, multi stakeholder processes for the tracking of the brick sector need to be put in place to undertake short term and long term measures for ensuring the brick sector is put on a low carbon path.

Impacts:

It is envisioned that even if 50% of the existing units in the state of Bihar adopt appropriate technology on improvement of existing brick production practices, the result will be a:

- Recurring saving of 250,000 – 300,000 tons of coal annually
- Recurring saving of 750,000 – 900,000 tons of CO_2 annually
- Recurring earning of Rupees 396 - 475 million from sale of carbon credits annually
- Reduction of black carbon (soot) resulting in abatement of global warming

The savings alone from CO_2 will result in a generation of a substantial amount from sale of CERs only each and every year. This - if "judiciously used" can be a trigger point for Greening the Brick Industry of Bihar.

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Chapter 1

Introduction

1.1. Background

The construction sector is an important part of the Indian economy with a contribution of 10% in GDP and registering an annual growth of 9%. The Indian brick industry is the second largest producer of bricks in the world after China. The brick production in India is estimated at 140 billion bricks, consuming 24 million tonnes of coal along with huge quantity of biomass fuels. The total CO_2 emissions are estimated at 41.6 million tonnes accounting for 4.5% of total GHG emissions from India. Brick production in India takes place in small units, using manual labour and traditional firing technologies. Large demand for bricks in urban centers has resulted in mushrooming of brick kiln clusters at the outskirts of major towns and cities. These brick clusters are important source of local air pollution (SPM, SO_2, fugitive emissions, etc) affecting local population, agriculture and vegetation. Apart from air pollution, brick industry also consumes good quality top soil for brick making. The industry is estimated to consume 350 million tonne of top soil every year. There are several opportunities exist in Indian brick industry to improve resource efficiencies and promote production of resource efficient bricks such as perforated bricks, hollow blocks and fly ash bricks.

1.2. Indian brick sector

Bricks are one of the most important building materials used in India. The Indian brick kiln industry, which is the second largest producer in the world, second only to China, has more than 100,000 operating units, producing about 140 billion bricks annually. Brick making is a traditional, unorganized industry generally confined to rural and peri-urban areas. The Gangetic plain of North India accounts for about 65% of the total brick production. Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal are the major brick producing states in this region. The availability of good fertile alluvium soils in North India makes the fringe areas of North Indian cities dotted with brick kilns and consequently this has become one of the major forces in bringing about land use/land cover changes around cities.

1.3. Baseline study area

The base line survey of Bihar brick sector was conducted in 6 different districts. The area covered in this project is mention below. Choices of districts were made on the basis of brick production and various types of technologies presently being available. Focus was also given on the selection of districts based on the growth potential. Details are given in Table 1.

Figure 1: Map of Bihar showing the surveyed clusters.

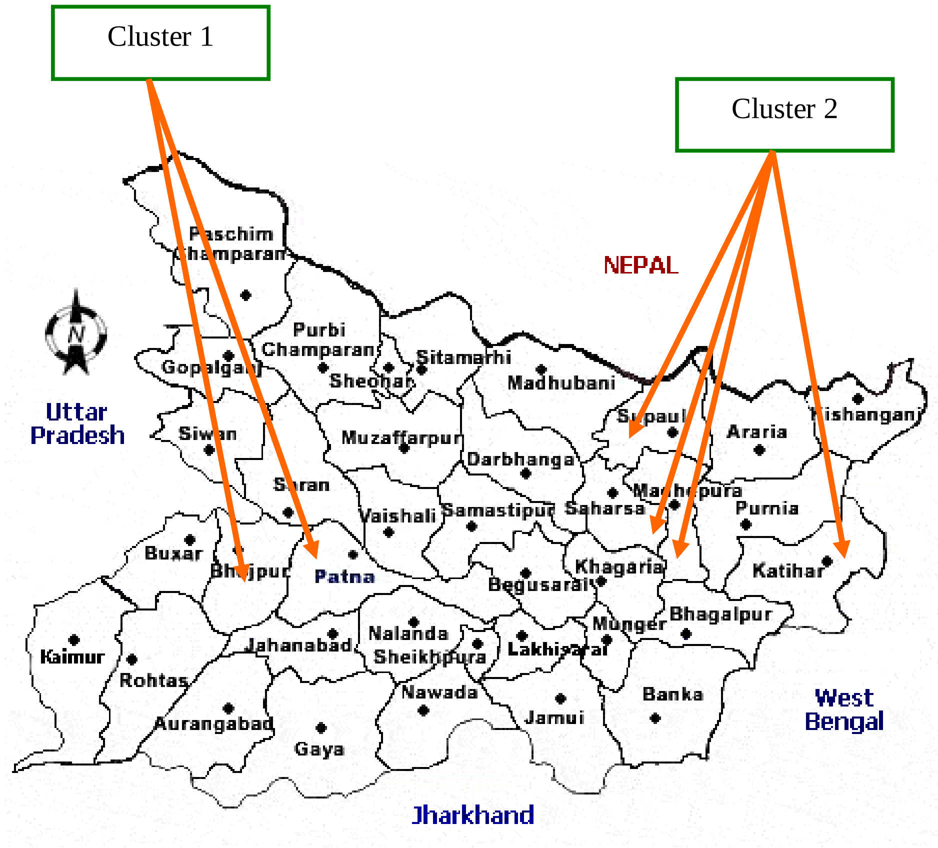


Table 1: Coverage of study area

Districts	Study Area
Cluster-1	
Patna	Sahpur, Chitnava,
Bhojpur	Sohadiya, Sangpur, Danupura, Jamira, Kaimnagar
Cluster-2	
Saharsa	Sulindabad, Saharsa
Supaul	Sokhpur, Belahi, Parsarma, Malhi
Madhepura	Bhantakthy, Mathahi, Chauk, Savela
Katihar	Bagmara, Miyapur, Bauliya

1.4. Objectives of the baseline study

- To understand the present scenario of brick industry in Bihar.
- To assess the market potential and business viability for ecofriendly brick production in allocated cluster areas.

1.5. Methodology followed

Phase – 1 (Survey design)

Survey design of the project consisted of the background study about brick sector in Bihar. It included the following steps:-

- Understanding the Project

- Designing the Questionnaire: A structured Questionnaire was prepared for the collection of primary data.

Phase – 2 (Data collection)

Both quantitative and qualitative data were collected during project period. Quantitative data includes soil and coal quantity in brick making, brick production capacity per day, cost of technology and selling price of final products. Qualitative data includes brick making process, soil and coal type, green and fired brick quality.

The required data was collected from both primary and secondary sources. Primary data was collected from Brick entrepreneurs, Builders and Secondary data collected from District Industry Centre (DIC), Khadi and Village industries Commission (KVIC), Directorate of Industries, BIhar as well as from different web sites articles as mentioned in reference part, The Energy and Resources Institute (TERI) and from Development Alternatives (DA) .

Phase - 3 (Consolidation and analysis)

Microsoft excel was used as a major tool for analysis of primary data.

- Tabular analysis and Graphical representation

Sampling Technique

In this project the technique of sampling used was **Judgment sampling.** Judgment sampling involves the choice of brick kilns that are most advantageously placed or in the best position to provide the information required.

Sample Design and size

Size of the sample was 50 brick kiln units depending upon the technology used in different locations. Table below gives details of the areas surveyed.

Table 2: Details of survey sampling based on available technologies

District	FCKBTK	FLY ASH	CLAMP	VSBK	MCBTK
CLUSTER 1					
Patna	5				
Bhojpur	5			2	
Total	10			2	
CLUSTER 2					
Madhepura	5				
Saharsa	5			1	
Supaul	5			1	
Katihar	5			1	
Total	20			3	

Chapter 2

Technologies being practiced

2.1. Brick making process

The main steps followed to make a brick are given below.

- Clay winning
- Clay transportation
- Clay grinding and ageing
- Mixing of additives
- Brick forming through moulding or extrusion
- Drying
- Firing
- Stacking and despatch

Material winning:

Normally the clay is procured from agricultural land. In some cases clay is also mined from river banks and river bed also. The clay is mined either manually or through mechanized means by JCB. However in most cases the clay is mined from the area where moulding is done.

Tempering:

This mined clay is then mixed with water and left to age for atleast 8-12 hours. Before watering the required additives are also sprinkled on the top of the clay. Just enough water is added to get the right consistency for moulding. Mixing is usually done manually with hands and feet. Sometimes and in certain areas where the clay is plastic in nature motor driven pugmills are used to mix the clay into soft dough. In some cases also soft mud moulding machine are also used to mould green bricks.

Moulding:

A lump of mixed dough is taken, rolled in sand and put into the mould. Initially moulds were made of wood, now metal moulds are used. Sand is used as a releasing agent so the brick does not stick to the mould and can easily be demoulded.

Drying:

The green bricks are demoulded into an open area. For proper shape it is ensured that the demoulding field is levelled and devoid of any foreign materials. After 24 hours when the green bricks become leather hard they are stacked in various open patterns to ensure enough airflow to dry the bricks. Every 2 days they are turned over to facilitate uniform drying and prevent warping. After 1 to 2 weeks they are ready to be fired into final shape.

Firing:

Various technologies are used for firing. In India normally green bricks are fired in continuous or intermitted kilns. The technology of firing depends on the resource availability and the green brick quality.

Sorting:

After the kiln is disassembled, the bricks are sorted according to colour. Colour is an indication of the level of burning. Over burnt bricks are used for paving or covering the kiln while slightly under burnt bricks are used for building inner walls or burnt once again in the next kiln.

Though the overall method remains the same, there are certain regional variations considering the local edaphic and climatic conditions. In different areas, different soil types are used with respect to local situation. The three general approaches for firing bricks include using a massive fire, a massive volume and insulation

2.2. Common building material products

Red Brick

Common fired clay brick is one of the important building materials in Bihar. Bricks are very traditionally used as walling material in most residential and commercial buildings. They are also used for other applications, e.g. road and canal construction. The brick size is generally 250mm X 120mm X 70mm. Throughout the state the red brick is the only available and used walling material.

Adobe

Although it was not observed during the baseline survey, however it was heard that in remote rural areas of Bihar especially in the hilly regions people do still use mud plastering as a major walling material. The mud plastering is given over a structure of bamboo or other structures. In some cases adobes are also used as a preferred walling material especially in the remote areas of North Bihar. The main reason of this type of walling materials is its affordability.

Fly ash brick

It is reported that some fly ash bricks are used in Bhagalpur region at NTPC Kahalgaon premises. However these are used in own construction and not for sale to common users. The brick size for fly ash usually is 230mm x 115mm x 70mm compared to the bigger size for burnt clay bricks.

The table given below shows that red brick is used both urban and rural area as major walling material in all the surveyed clusters. Instances of fly ash brick are rare.

Table 3: Common building material products being used district wise

	Urban				Rural			
District	**Red Brick**	**Fly Ash**	**Adobe**	**Concrete block**	**Red Brick**	**Fly Ash**	**Concrete**	**Adobe**
Cluster-1								
Patna	Major	NA	NA	Occasional	Major	NA	NA	NA
Bhojpur	Major	NA	NA	NA	Major	NA	NA	Occasional
Cluster-2								
Madhepura	Major	NA	NA	NA	Major	NA	NA	Minor
Supaul	Major	NA	NA	NA	Major	NA	NA	Minor
Saharsa	Major	NA	NA	NA	Major	NA	NA	Minor
Katihar	Major	NA	NA	NA	Major	NA	NA	Minor

Source: Observation during primary survey

2.3. Technology used for brick production in Bihar

In India the variants of the Bull's Trench Kiln is the most common brick firing technology followed. Previously it was the movable chimney variant with two steel chimneys on an oval base. After its ban by the Supreme Court, the movable chimney has been replaced by various variants of the continuous brick firing technologies e.g. the fixed chimney BTK, zig zag kiln with forced draught, the vertical shaft brick kiln. Despite the ban of movable chimney BTK across the country, there are many states where it is still under operation. Amongst all the states in India, Bihar is the only state where entrepreneurs have successfully followed the conversion of movable chimney to fixed chimney BTK. This is attributed to the strict enforcement of the same by concerned regulatory authorities and willingness of entrepreneurs in moving to newer firing methods. Instances of alternate technology e.g. the forced draught zig zag kiln and vertical shaft brick kiln are slowly gaining popularity. Fly ash technology has yet not been a popular technology due to the absence of raw material available within a profitable distance.

Technical details of the technologies are given below:

Fixed chimney BTK

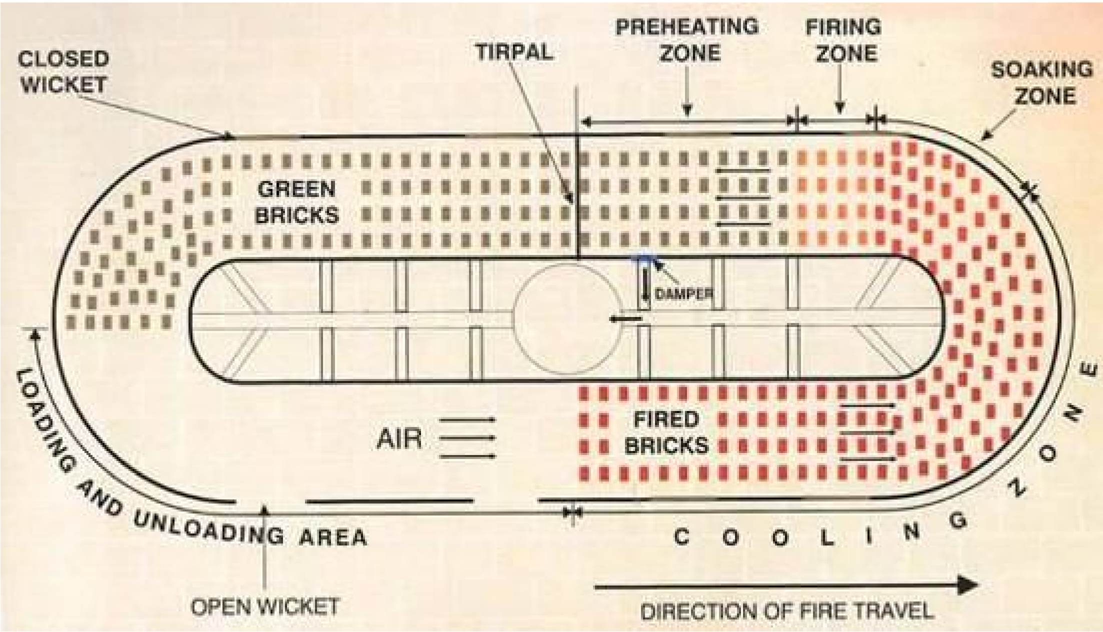
In 1996, following a Government order to ban movable chimney BTK and raise stack height to 100 ft, movable chimney BTK's were to accommodate taller and permanent fixed chimney's. Underground piping (gravity settling chamber) was necessary to divert the flue gas to the chimney. This also required extending the width of the base. The taller chimney creates a stronger draft, which improves combustion to some extent and enables flue gas to be released at 100 ft, dispersing the pollutants over a wider area. With the present form, it has a slightly improved energy efficiency compared to movable chimney BTK.

Main features of fixed chimney design

1.	Chimney height		100 -120 ft
2.	Chimney cross sectional area		
	a.	Top opening	16 – 25 ft
	b.	Bottom opening	225 ft
3.	Flue duct cross-section area		4 ft x 4 ft

Principles of operation of fixed chimney kilns

The kiln can be divided into three zones; brick cooling, preheating and combustion zone. In the cooling zone air picks up heat from the fired bricks while in preheating zone, green bricks are heated by the hot combustion gases. In both cases the mode of heat transfer is convection. Convective heat transfer depends on the temperature difference between the gas and the solid as well as on the speed with which the gas passes the solid.



In combustion zone the fuel is fed from the top through the fire holes. Most of the solid fuel drops down to the bottom of the setting and burns on the floor of the kiln. The combustion of fuel depends on:

- Properties of the fuel
- Temperature and size of fuel particles
- Availability of air for combustion
- Fuel feeding rate

Control of air flow

The amount of air flow through a kiln controls both the combustion as well as heat distribution in the kiln. In general higher is the air flow rate higher is the fire travel in the kiln. The air flow in the kiln is achieved with the help of chimney. The hot gases inside the chimney are lighter that the ambient air outside the kiln. The difference in weight between the hot air column inside the chimney and outside air produces a pressure difference which is known as draught. This pressure difference results in air movement in the kiln. The setting in the kiln provides resistance to air flow and therefore the quantity of air flowing through a kiln depends both on the draught produced as well as resistance provided by brick setting, flue ducts and chimney.

Cold air leakage is also an important parameter affecting air flow in kilns. The chimney puts the kiln under suction and so cold air tends to be drawn through any cracks and fissures within the kiln structure. Most of the cold air leakage takes place in the flue ducts through the cracks in the temporary partition walls erected to seal the flue ducts not in use. Cold air drawn in reduces the average temperature of the hot gases in the stack and so reduces the static draught. In addition, energy is consumed in moving air unnecessarily through the kiln and up the chimney.

Coal charging and coal properties

An area of concern in the kiln operation is the coal feeding in fixed chimney kilns. Presently coal is generally fed intermittently with intervals between two successive feeding operations ranging from 20-30 minutes to even an hour. At any given time coal is generally fed in 2-3 rows and due to heavy charging of coal, thick black smoke can be observed coming out during and just after the coal feeding operation.

When a fairly large charge of coal is fed, smoking is liable to occur for two reasons:

1. The coal bed is deepened and the diffusion of air into the coal becomes difficult
2. Addition of cold fuel reduces the temperature of the fuel bed resulting in incomplete combustion.

The other factor which affects combustion is the quality and particle size of coal. The time for combustion of solid fuel depends on particle size. The present practice of feeding large sized coal and lumps results in wastage.

High draught kilns

High draught kilns are normally termed in Asia countries e.g. India, Nepal, Bangladesh as Zig-Zag kilns. It should be mentioned here that Zig-Zag is only a firing pattern followed in High Draught kilns.

In these type of kilns, the length of the kiln gallery is increased by zig-zagging the chambers and the fire follows a zig-zag path instead of a straight path followed in BTK. At any point of time these type of kilns were widely used in developed countries particularly in Germany and Australia. In Europe, the interior cross-section of the kiln used to be small in original zig-zag kilns (7.5 ft wide x 7.5 ft high) and the kiln used to have 16-20 chambers each 20-25 ft long. Fan draught was provided and the kiln operated on high draught at a very fast rate of fire travel (50-100 ft per day). The Habla kiln developed in Australia is a form of zig-zag without crown and in which the division walls between chambers are made of green bricks. The top of the setting is covered by a layer of two or three courses of bricks followed by a layer of ash.

The Zig-Zag firing concept in India is generally introduced and followed in the form of a High Draught (HD) kiln. The HD kiln has several similarities with the Habla kiln. The kiln consists of a rectangular gallery which is divided into 24 chambers by providing temporary partition walls with green bricks. The wall of each chamber runs along the width of the gallery except one end, wherein a space of 60 to 65 cm is left for communication to next chamber. Draught is created by an induced draught fan with a 20-35 HP motor for proper combustion of fuel. Depending on the design capacity of a kiln, a chamber can hold 7,500 to 15,000 bricks. Normally two chambers are fired per day and a output of 15,000 to 30,000 bricks per day can be obtained. When brought to full firing, the kiln operates on a draught of 50 mm HG. However several problems are being encountered in the HD kiln in different countries:

1. Bricks remain too hot for handling at unloading point.
2. Dampers in the flues provided in the inner wall communicating with the main central flue being too close to the firing floor, were exposed to high heat resulting in rapid deterioration.
3. As the draught and hence the negative pressure in the kiln is several times more than that observed in fixed chimney BTK's, the HD kiln is also more susceptible to air leakage. Most of the leakage takes place through wicket walls and through leaking valves and dampers.

Specific energy consumption of around 1.35 MJ/kg of fired bricks has been achieved in HD kilns being operated under full capacity. However it is generally observed that due to shortage of trained manpower and lack of exposure to proper operating practices the performance of HD kilns are much below the expected level of performance. Moreover, in most of the rural areas either electricity supply is not available at brick kiln sites or the supply is not reliable. Therefore installation of a DG set for electricity generation becomes essential with a High Draught kiln which further adds to the complexity of the problem.

Clamp

Clamps are used for smaller production levels. A variety of fuels such as coal, firewood, various types of agricultural residues and dung cakes are used in clamps. Large variations are observed in the shape, size, stacking of bricks and firing techniques in clamps. Generally, energy efficiencies of clamps are lower. The specific energy consumption of clamps ranges between 1.5 and 3.0 MJ/kg of fired brick. In Bihar Clamps are not used for commercial brick production and there is a limit of 1 lakh bricks on a clamp that is producing bricks for commercial purposes.

VSBK

A Vertical Shaft Brick Kiln (VSBK) is an energy efficient technology for fired clay brick production that originated in China. The VSBK technology considerably economizes on fuel cost, with savings of between 30to 50% when compared with other common firing technologies such as Clamps or Bull's Trench Kilns. Pollution levels are extremely reduced compared to other prevalent methods of brick firing. Although no VSBKs were covered in the sample survey, there is a VSBK's in Ara, Bhojpur district and more bring set up in other districts of Bihar.

Fly ash brick making

The process comprises of mixing the raw materials using the pan mixer for 4-5 minutes and then transferring the material to press machine with the help of conveyor belt. Next, the compressed blocks are transferred to a curing yard with the help of wooden pallets on which the blocks are pressed using the press machine. The blocks are then water cured for minimum 14 days. After 14 days of curing bricks are kept for 7 days in dried place, after that it is ready for sale. The composition of a typical Fly Ash Cement brick is given as below

- Fly ash - 40-50%
- Sand - 40-45%
- Cement/Lime/Gypsum - 8-12%

Fly Ash Brick making requires Fly Ash that is a waste material from Thermal Power Plants and there are currently very few such plants in Bihar and thus this technology is only feasible in areas where raw materials are available.

2.4. Raw materials for brick production

The raw materials used for burnt clay brick production are soil and coal. Industrial wastes or dust coal can also be used as internal fuel in green bricks. Apart from burnt clay fired bricks lime or cement stabilized cured blocks can also be produced from a mixture of fly ash (thermal power plant waste) and sand.

In Bihar the major raw materials used in burnt clay brick making is only soil and coal. This is mainly due to the availability of good quality soil in Bihar. Majority of brick making activity is from soil excavated from agricultural land. In some isolated cases soil is procured from river bed. Aerial photos given below (Figure 2a,b) shows the effect of soil excavation for brick making both from agricultural land and from river bed.

Figure 2a. Google photo of brick kilns situated in river banks near Patna

Figure 2b. Google photo of brick kilns situated on agricultural land near Patna

The graph given in Figure 3 shows the approximate distribution of soil use in Bihar. It can be seen that despite the availability of good quality soil from river beds, more than 90% of the soil used is from agricultural land.

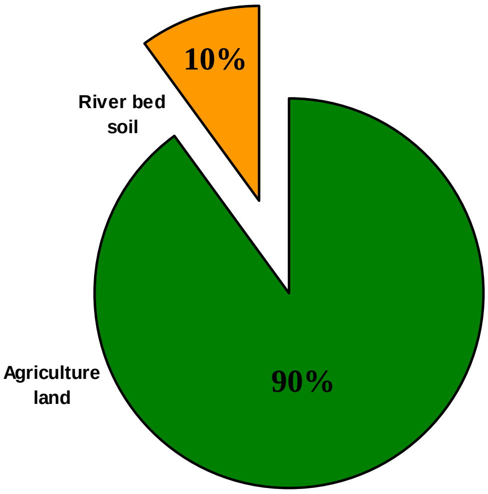


Figure **3: Comparison of soil use in brick making**

It is estimated that brick making activity in Bihar consumes approximately 16,500,000 m^3 of soil each and every year. With this soil quantity approximately 5,500 acres of land is transformed into barren land each and every year. This is equivalent to the loss of around 7,000 tons of rice production each year depriving 1,10,000 people from their daily food.

Apart from soil, the major raw materials used to fire the green bricks are coal and wood. In the state of Bihar around 60,000 tonnes of wood is used in brick production each and every year. The wood is used primarily during the initial firing to dry up excessive moisture. However most of the wood is sourced illegally from nearby and adjoining forests. This amount of wood is equivalent to around 300,000 full grown trees which takes around 20 years to grow. This type of rampant use of full grown trees will certainly lead to uncontrollable deforestation depleting the forest cover of the state of Bihar.

Apart from fuelwood, the entire coal used in the state comes from either Jharkhand or Assam. The major area of coal procurement in Jharkhand is from Dhanbad, Jharia, Hazaribag. In Assam majority is supplied from Guwahati and nearby areas. On an average 22-24 tons of coal is used for firing a lakh of bricks. The price of coal from Assam is generally higher than Jharkhand coal due to high transportation costs. Normally North Bihar uses coal from Assam whereas Central and South Bihar uses coal from Jharkhand sue to proximity and lower transportation costs. The prices of coal and usage are given in Table 4.

Table 4: Coal price and usage pattern in Bihar

District	Rate (Rs/Ton)	Coal consumption (Ton/year)	Total coal expenses (Rs. in lakhs)
Cluster 1			
Patna	5,600	452	25.30
Bhojpur	6,020	450	27.07
	Average	**451**	**26.18**
Cluster 2			
Saharsa	9,000	450	37.70
Supaul	9,740	520	50.91
Katihar	9,800	520	49.20
Madhepura	9,500	660	62.50
	Average	**537**	**50.08**

2.5. Potential raw materials for brick production

For the state of Bihar the potential raw materials for brick making in the coming years will still be common soil. It is a common belief that good brick cannot be made from normal river bed soils. On the contrary apart from saving of agricultural soil, use of river bed soil will also promote de-silting of the rivers thereby promoting flow of excess water arresting flood during the rainy season.

Apart from soil fly ash brick will be the choice of brick makers in the immediate future. In Bihar, there are currently very few thermal power plants from where fly ash can be made available to brick makers. However there are several new plants that are in the process of being commissioned by the year 2012 – 2013. The appropriate use of industrial wastes and hollow bricks can also save top soil.

Currently Fly Ash technology is only being used on a pilot basis at National Thermal Power Corporation (NTPC) in Kahalgaon, Bhagalpur district. Bricks are being used by NTPC itself in their own construction and not being sold for private or public use. However there is further potential for brick production in Kahalgaon as well as in other areas. The Thermal power plants that can currently be tapped for use of fly ash in brick making are given in the Figure 4. Additionally, boiler ash from sugar mills can also be used as internal fuel in green bricks to improve resource and energy efficiency. There are currently nine sugar mills operating in the state. The availability of boiler ash is mapped in Figure 5.

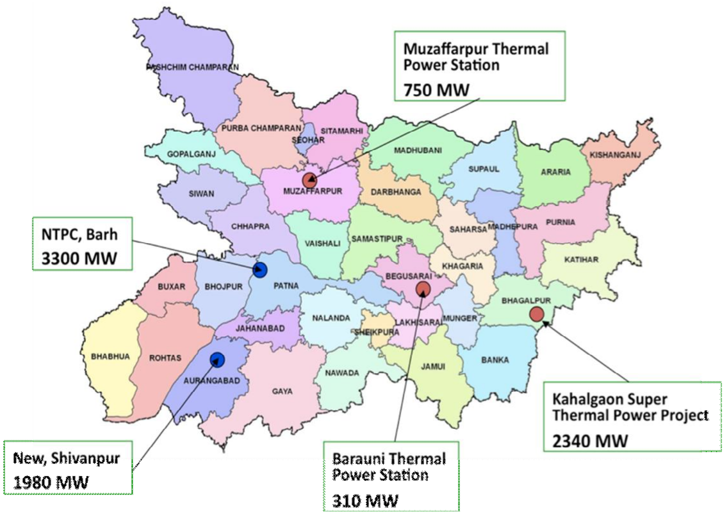


Figure 4: Potential sources of fly ash waste

Figure 5: Potential sources of boiler ash from sugar industries

2.6. Mechanization used

In Bihar mechanization was seen in soil excavation and soil preparation. However no mechanization was observed in green brick fabrication due to the easy availability on intra state moulders.

The mechanization used for soil excavation is JCB machines. They are mainly used to stock soil and age them. Moreover since soil is procured from outside thus use of JCB in digging becomes feasible to reduce labour costs and increase productivity. However due to high capital cost, (Rs. 20 lakhs) JCB is not owned by brick entrepreneurs. Instead they are rented from external sources at a cost of Rs. 800 per hour. During a production of 8 hours, a single JCB can dig soil equivalent to around 120 tractors (1 tractor = 80-100 cft) which is enough to support production for a period of 5-7 days. Thus it is economically feasible to use a JCB.

Apart from JCB, the use of motorized pugmills was common to the entire surveyed areas. Usually the pugmills are electrically driven or run by diesel engines. They are generally used to uniformly process the silty and clayey soil procured in the area.

No other mechanization was observed during the survey. This might be due to the easy availability of unskilled workers in Bihar unlike other states where the use and demand of semi mechanized soft mud moulding machine was favoured.

2.7. Brick quality mapping

Generally the brick quality in Bihar is excellent compared to other adjoining states. This is due to the availability of silty soil. Normally fired brick strength of around 70-125 kg/cm2 has been observed in the surveyed clusters with good metallic ring. However colour of the bricks varies due to variation in the soil quality. Processing of soil by pugmill might be an additional reason for getting good fired brick properties.

Chapter 3

Energy and environmental status

3.1. Energy consumption and environmental status in the brick sector

The dominance of FCBTK technology poses environmental threats and challenges in the Bihar brick sector. Brick firing, especially in FCBKT is an energy intensive process. There are alternative technologies available that are more energy and resource efficient and emit lesser green house gases. For instance the Vertical Shaft Brick Kiln consumes 40% less energy compared to FCBTK through the waste heat recovery system and emits almost 70% less emissions. The fly ash cured block technology does not use fossil fuel and therefore has no emissions.

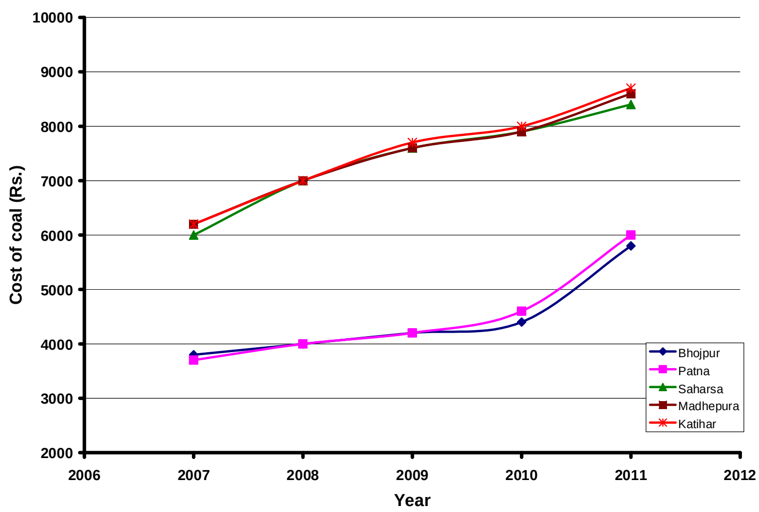
Globally, most of the countries are shifting from FCBTK to more environment friendly technologies. The most pioneering step has been taken by Bangladesh in banning FCBTK technology which is the most dominant brick firing technology in the country similar to Bihar. Nepal is also encouraging shift to more environment friendly technologies like VSBK.

3.2. Trend in coal price

The annual estimated coal consumption by the brick industry in India is 24 millions tonnes, which represents 8% of the total coal consumption in the country. Besides coal, the brick industry also consumes a large quantity of biomass fuels. The share of fuel in the total production cost of bricks is in the range of 60% to 65% and is increasing further.

Between the years 2010 to 2011 the price of coal in the state has increased drastically as shown in Figure 6. The price of Dhanbad coal being used in Patna has increased from Rs. 4900 to Rs. 6020 per MT of coal; an increase of more than 20%. The price of Assam coal in Madhepura increased from Rs. 8000 to Rs. 9500 per MT of coal; an increase of 18%. This is a very serious concern for entrepreneurs all over the state that is having an impact on the profitability of the brick sector.

Figure 6: Trend in coal prices in various clusters



3.3. Diesel consumption details

One of the major sources of energy prices in brick production cost is contributed from the use of diesel. Due to shortage of electricity in the brick manufacturing areas diesel is extensively used for any mechanization processes in the brick industry. In Bihar, diesel is used in transportation, soil excavation, soil mixing and diesel pump sets for the extraction of water. In the sample survey, on an average 6970 liters of diesel was used for one brick season. The most diesel consuming areas are Patna and Madhepura because of higher levels of mechanization as can be seen in the graph below. In terms of mechanization the soil extraction process with the JCB consumes maximum diesel. Table 5 given below gives the idea of diesel consumption in Bihar.

Table 5: Trend of diesel consumption in various steps of mechanization

Technology	Diesel consumption (litre/hour)
JCB for soil excavation	5.0
Pug mill for soil mixing	1.5
Diesel pump for water	1.0

Figure 7 below shows the yearly expenses from diesel consumption in various districts from FC BTK operation.

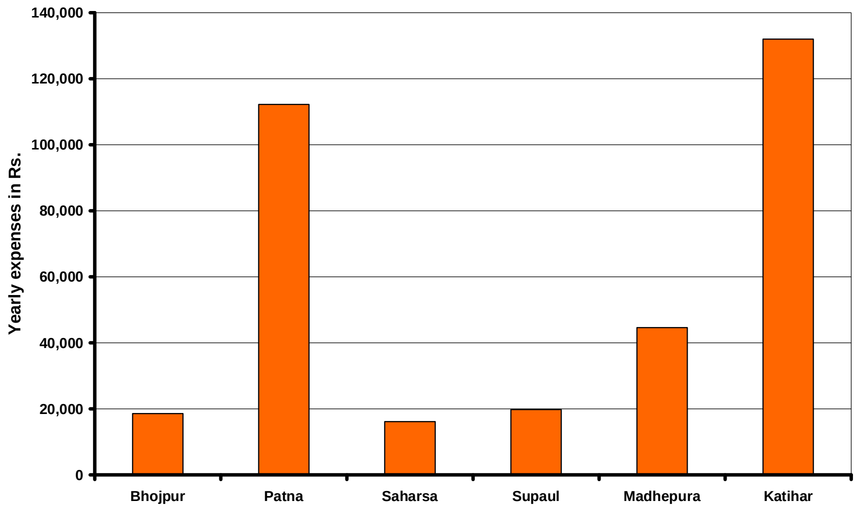
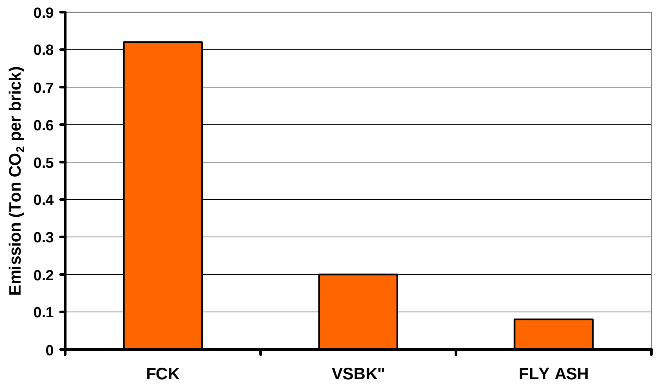


Figure 7: Yearly expenses from diesel consumption in various districts of Bihar

3.4. Environmental issues

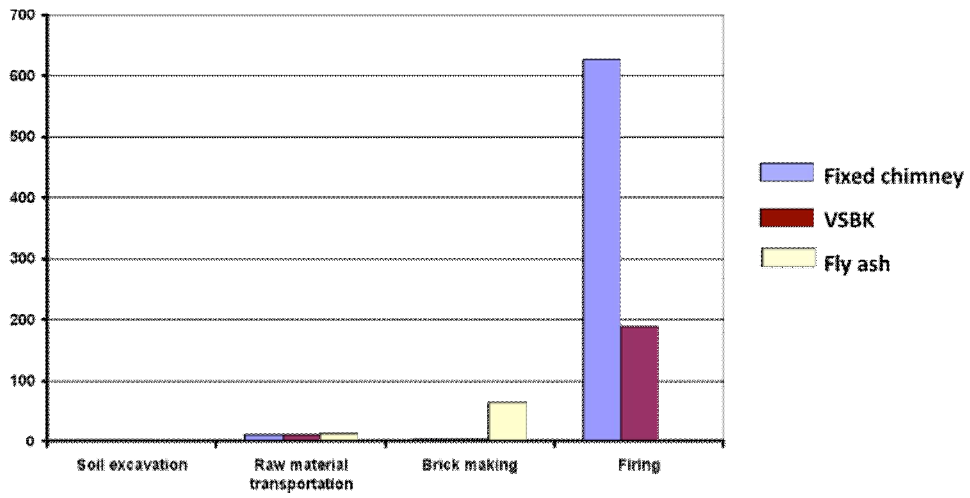
Brick making has been identified as one of the most polluting industries in the small scale sector by the Central Pollution Control Board (CPCB). Brick kilns are estimated to emit 42 million tonnes of CO_2 every year. Apart from air pollution the brick industry also consumes large quantity of top soil, estimated at 350 million tonnes every year. The graph given below (Figure 8) shows the CO_2 emissions from various technologies being used in other states. Thus, if adopted, there is a potential of CO_2 reduction even in the state of Bihar in the longer run.

Figure 8: Total CO_2e emission per brick from various technologies



In the Bihar brick sector, there are various source of energy consumption like soil excavation, raw material transportation, brick making and firing, however firing consumes the most energy. Emissions from soil excavation and raw material transportation are negligible. Emissions are negligible in brick making for red bricks that are moulded by hand (Figure 9), however in fly ash bricks, around 60 tonnes per 1000 bricks is emitted which can be attributed to electricity and diesel use. In the case of firing in fly ash bricks there are zero emissions and in FCBTK technology emission is around 630 tonnes per 1000 bricks but in VSBK technology is around 180 gram per brick.

Figure 9: Total CO_2e per 1000 bricks from various technologies



Chapter 4

Awareness issues

4.1. Awareness and inclination to change

The primary survey was used to assess awareness about new technologies available in the market including mechanization. While 53% entrepreneurs were aware that new technologies exist in the market, 47% were not aware.

Figure 10: Knowledge of eco-friendly technology

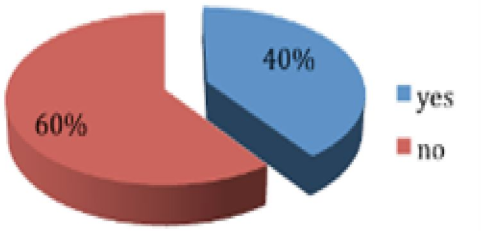
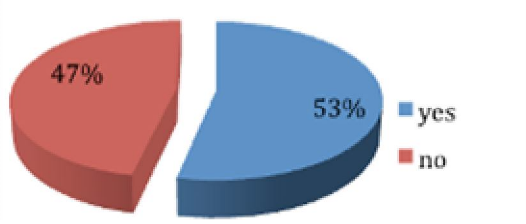


Figure 11: Knowledge about new technologies



Technology used in the state is predominantly the traditional Fixed Chimney Bulls Trench Kiln, which is an energy and resource intensive technology. When asked about information on eco-friendly technologies that can reduce coal consumption, there was less information available among entrepreneurs. 60% of respondents were not aware of any eco friendly technologies. In the survey, entrepreneurs had no inclination to modify or switch to new technologies; only 23% respondents were willing to modify their technology to make it more eco-friendly. This is obvious since no entrepreneur will be willing to take risk with any new technologies which ahs not yet been heard of or can be seen under operation in the state.

4.2. Brick sector clearances

Figure 12: Willingness to modify technology

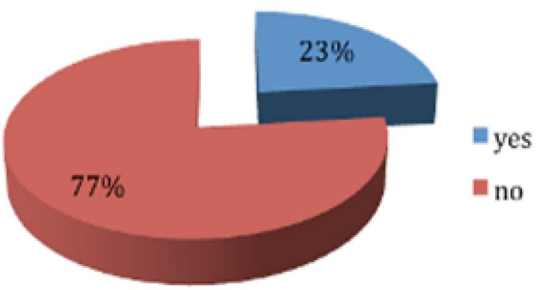
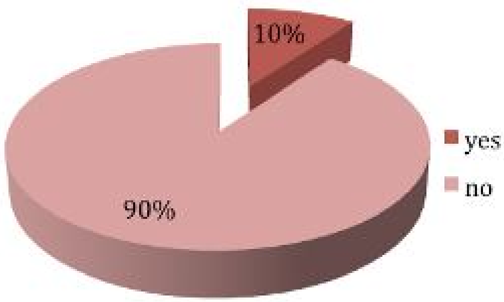


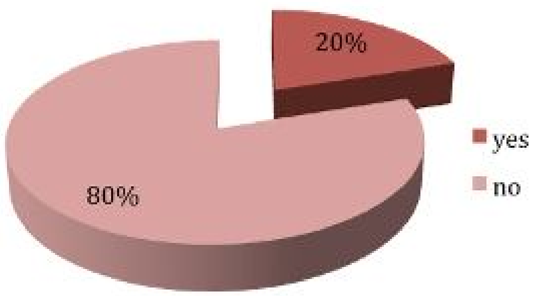
Figure 13: Status of DIC registration



District Industry Center (DIC) is the state government body which promotes small and micro enterprises at the district level and provides access to various schemes like subsidy, pollution control, registration etc. However, most of the entrepreneurs in the brick sector in Bihar have not registered themselves with DIC. This is depicting the true rural and unorganized nature of the brick business rampant in Bihar. It is surprising that these units have themselves registered with Mining and Pollution Control Board. It is also contradictory on the availability of State Pollution Control Board NOC, since without a valid DIC registration NOC cannot be available. Only 10% of respondents surveyed had registered with the DIC. This also can be attributed to a lack of financial incentives in terms of subsidies or innovative schemes provided to entrepreneurs by the DIC.

Additionally, the brick sector remains unorganized and it is difficult to monitor individual brick entrepreneurs. Unlike several other small scale industries, there is no unified association in the brick sector in the state of Bihar. Although 20% respondent stated that they are members of a brick association, this body operates sporadically and is not officially recognized.

Figure 14: Member of brick association



Chapter 5

Market and financial trends

Brick production in the state of Bihar depends on the plant capacity; which varies from 20 – 60 lakh bricks per year. It is also dependent on other factors such as availability of labour and raw material and weather. The FCBTK runs for an average of 6 - 7 months a year, and has to shut down production during the monsoon season. As can be seen from the graph below, brick production ranges between 19.4 lakh in Supaul to 40 lakh in Madhepura with an average production in the sample clusters of around 25 lakh per year.

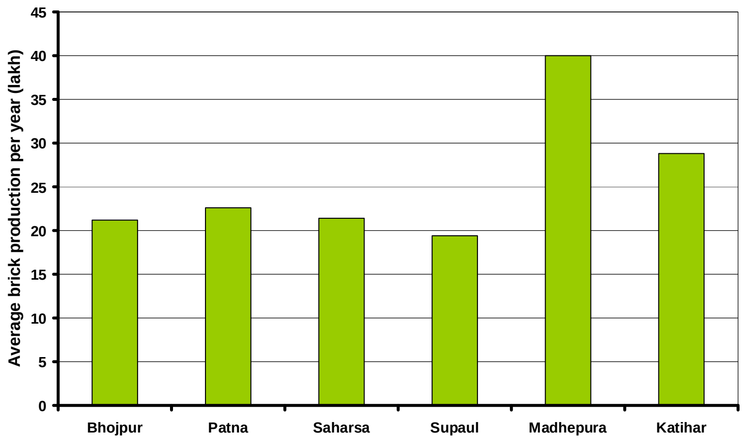


Figure 15: Average brick production in surveyed districts

5.1. Annual turnover

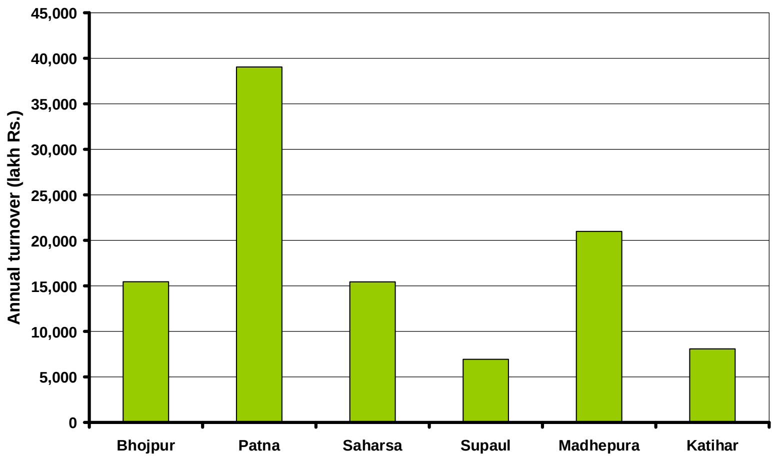


Figure 16: Annual turnover from brick production in surveyed districts

In Bihar, the demand of red brick is very high because of no alternative substitutes such as fly ash, concrete block etc. Patna has the highest turnover within the brick sector bringing in Rs. 39052 lakhs followed by Madepura. The turnover from Cluster 1 and 2 is over a 1000 crores. This shows that brick business is a high turnover business which should be an attractive proposition for the finance sector.

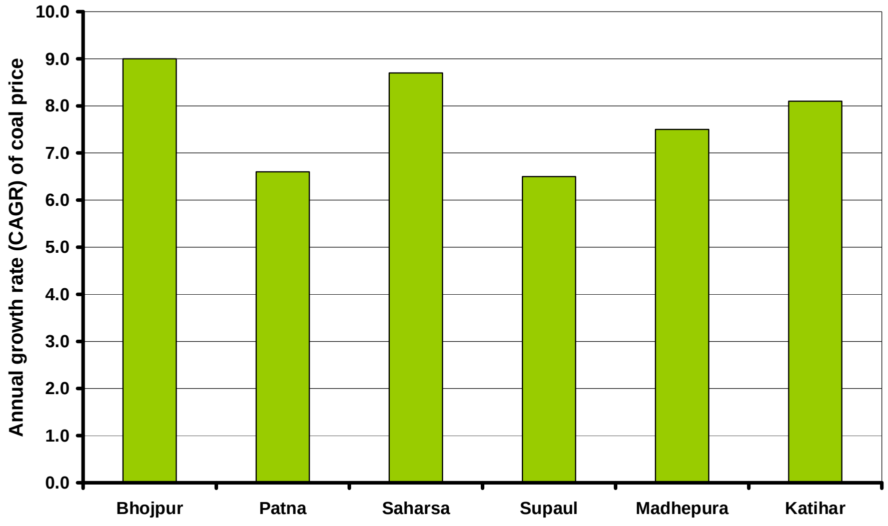
5.2. Trend in production cost

The production cost of brick production in the state is increasing and will continue to increase mainly because of rise in coal prices every year. Between 2007 to 2011, in Bhojpur district the coal price increased at compound annual growth rate (CAGR) of 9%. In Patna district it was 6.6%. Graph below shows the growth rate of coal prices in the surveyed clusters. In both the clusters the average CAGR of coal is around 8%. This is due to the increase in price of coal and increase in transportation cost due to rise in diesel prices.

No definite production cost could be ascertained from surveyed entrepreneurs. This is mainly due to reluctance of entrepreneurs in disclosing the same. Thus it is implied that brick production is a profitable business since entrepreneurs would not like to disclose the same in open.

It was derived that the production cost per 1000 bricks ranges between Rs. 3500 to Rs. 4000 in the surveyed districts. In the study the lowest cost of production was in Ara (Rs. 3400) and the highest cost of production in Madhepura (Rs. 4060).

Figure 17: Annual growth rate of coal prices



5.3. Trend in selling price

The selling price of bricks is also increasing but not proportionate to the increase in production cost. Therefore profitability is decreasing. In cluster 1 the compound annual growth rate of selling price is around 6.4% and in cluster 2 it is around 7%.

5.4. Trend in profit

In the surveyed districts of Bihar, profitability is decreasing because of increased production costs. In fact in cluster 1 the compound annual growth rate of brick is around -1%, indicating decreasing profits. In cluster 2 it is around -3%. The highest compound annual growth rate is

-6% is in Saharsa and followed by Katihar at -3%. In almost all the districts the profit ranges between Rs. 500 to Rs. 780 per 1000 bricks.

Figure 18: Trend in selling price of bricks

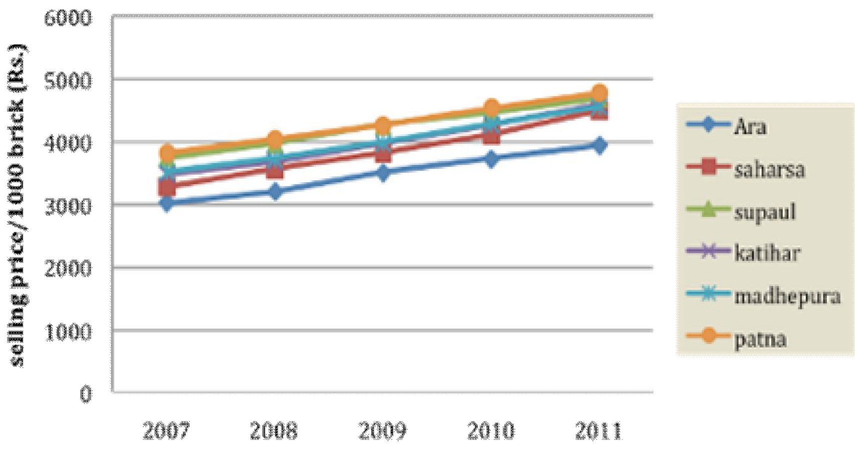
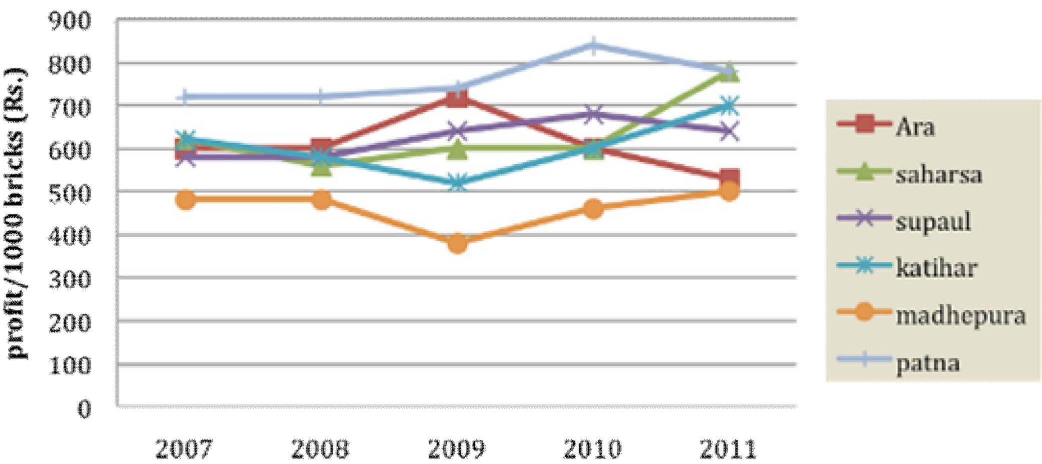


Figure 19: Trend in profits from brick business



5.5. Financial trend in the brick sector

In the surveyed clusters of Bihar no instances of financing of brick kilns was observed. Upon discussion with brick entrepreneurs it was learnt that they do not avail of any finance. The reason was two folds. Most of the entrepreneurs are ignorant on the schemes and availability of finance for manufacturing units. On the other hand the financial institutions are averse to loaning (both for fixed and working capital) to brick entrepreneurs due to their rural setting and nature of business. On the other hand these financial institutions (State Bank of India, Punjab National Bank etc.) have and are willing to provide only capital loans for movable properties e.g. vehicles, equipments etc.

Entrepreneurs are also ignorant about the various schemes and subsidies given by the Government. This is derived from the fact that the flagship PMEGP scheme of the Government of India is grossly under utilized compared to other states. Only about 30% of the subsidies have been utilized by the State Government under this scheme. This under utilization is also attributed to banks apathy to provide loans to the SME sector inspite of loan securement of around 25-30% through the subsidy amount.

Chapter 6

Social mapping of the brick sector

The brick sector is a major source of employment providing jobs for approximately 10 million workers nationally. In Bihar, the brick sector finds it labour from within the State as well as migratory labour from neighbouring Uttar Pradesh and Jharkhand. There are various categories of workers on a brick kiln such as moulders, firemen, unloaders and managerial staff.

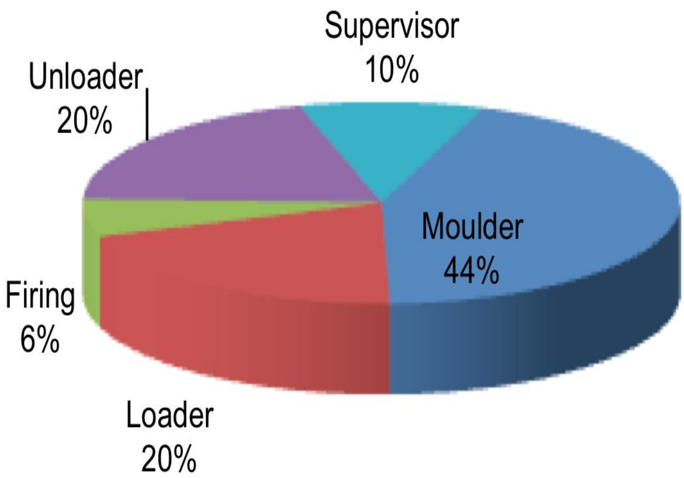
Increasing labour cost

Labour costs in the state of Bihar are increasing and shortages of certain types of labour are leading to pressure on the brick business. The total labour cost in the production of a brick is Rs. 0.99. A description of the labour costs involved in the 2 clusters is given below.

Moulder:

There are currently serious problems being faced by the brick sector from the shortage of skilled moulders. Moulders charge a high advance of Rs. 15,000 per moulder family.

Figure 20: Distribution of labour expenses in brick production



In Cluster 1 (Bhojpur and Patna), there is an average of 45 moulder families in each kiln. The average remuneration of moulder on 1000 bricks is Rs. 410. In Cluster 2, there is an average of 55 moulders in each kiln and the piece rate per 1000 brick is Rs. 430.

Loader:

Green bricks are left in the sun for approximately one week to dry. Then they are transported to the kiln on animal driven carts or donkeys. This work is physically taxing and carried out by men and boys. Once they reach the kiln, the brick are stacked in the kiln for firing. The average wage of loader in study area, in district Bhojpur, was the highest i.e. Rs 245 per 1000 brick followed by Supaul at Rs. 190. The average cost of loader per brick is Rs. 0.17.

Fire men:

There are 4 to 5 fire men and a mistri involved in firing a kiln. In Bihar, the firemen are migrant labour from Uttar Pradesh (two districts, Allahabad and Raebareli). This migration is seasonal, from January to June. The advance payment to labour in the districts is around Rs.10,000. Firemen have a fixed salary of Rs. 6000 per month. In cluster 1 the average firemen on each kiln was 5. Thus the cost of firemen per brick was Rs. 0.58. In Cluster 2 the average firemen on each kiln was 5, with an average cost of firemen per brick being Rs. 0.60.

Permanent staff:

The management hierarchy in the brick sector industry includes site manager, supervisor and some office staff which are permanently employed. In brick industry the involvement of entrepreneur is very high and is responsible for all decisions. In district Bhojpur the average permanent staff cost per brick ranges between Rs. 0.08 to Rs. 0.20.

Chapter 7

Key issues in Bihar brick sector

Bricks are the main building materials used for walling and as fillers in the construction of residential houses, commercial buildings, canals, dams etc. The brick sector in the country is unorganized and polluting, thus often exempted from policy and financial incentives provided to other small and medium industries. Although there are alternative technologies available, which are more energy and resource efficient, traditional technologies such as the Fixed Chimney Bulls Trench Kiln and Clamps are predominant, especially in the state of Bihar.

A field study was done in 5 districts and 2 clusters in the state of Bihar to understand the present scenario of the brick industry. The sector is dominated by one technology i.e. the fixed chimney kiln. However there is potential to improve the existing technology as well as introducing new cleaner production technologies to reduce pollution and mitigate emissions. Some of the barriers are the lack of awareness amongst brick sector entrepreneurs, lack of demonstration of such technologies in the state and scope in the improvement of the policy and financial regime towards environmentally friendly brick technologies.

To overcome these barriers, the state and central government have a role to play in terms of ensuring the promotion of energy and resource efficient bricks and mainstreaming such technologies.

Key issues in the brick sector

- **Energy intensive brick making technology:**
  The FCBTK is a resource intensive and energy intensive technology for brick making and emits over 600 tonnes of CO_2 per 1000 bricks in its firing processes, as compared with alternate technologies that are upto 40% more energy efficient in their firing processes. The brick sector in Bihar is dominated by the FCBTK technology, and currently there are no cleaner and more resource efficient technology alternatives.

- **High level of pollution:**
  The brick sector is the most polluting sector among other small-scale industries. Currently in Bihar because of a lack of clean technology, the brick sector not only emits high amount of carbon emissions but also other harmful gasses such as Sulphur Dioxide (SO_2), Nitrous Oxide (NO_x), Carbon Monoxide (CO) and particulate matter that is harmful for health as well as surrounding agricultural land, orchards etc.

- **Resource intensive:**
  Currently the sector depletes large amounts of coal, soil and wood. The cost of coal has risen by almost 20% in areas of Bihar from 2010-2011 and will continue to rise. This has raised the cost of production of bricks and reduced the profit margins for brick makers. Clay required for brick making is obtained from land, which could otherwise be used for agriculture. The loss of soil fertility and associated impacts of

soil erosion are serious issues raised by the brick sector. Additionally, 60,000 tonnes of wood per year are used for brick making in the state, causing deforestation in the state.

- **No formal financial regime and poor markets:**
  There is a lack of access and tailor made financial instruments to finance the modernization and upgradation of the brick industry. Additionally, because of a lack of awareness, there are poor markets from new types of bricks such as fly ash bricks or concrete bricks and a perception that bricks from alternate technologies are of poor quality prevails.

Chapter 8

Key barriers for acceleration

The barriers that are responsible for stagnation of the brick sector and inhibiting technology up gradation have been detailed below:

Policy

The existing codes and specifications for building materials are based on traditional brick making technologies and do not meet modern practices and technologies. With the availability of new building materials, these codes and specifications need to be reviewed and modified for large-scale production and use. Currently incentives to switch to cleaner technologies in the brick sector are lacking both in terms of financial incentives as well as in terms of a preferential regime for environmentally friendly brick technologies. In fact, currently the mining royalty structure in Bihar is a compounded rate based on the average consumption of clay by FCBTKs, although new technologies use less soil.

Financial

There is a lack of awareness and knowledge among brick entrepreneurs necessary to prepare project reports/ documents for seeking loans from financial institutions/ banks. The credit-worthiness of brick kiln entrepreneurs is not favorably viewed by banks. At present, there is no tailor-made financial instrument available to brick kiln entrepreneurs for investing in technology upgradation.

Business Skills

The majority of brick kiln entrepreneurs use traditional methods of green brick production, brick firing and marketing. They lack capacities in regard to modern practices in marketing, buisness opportunities and kiln management. There is also a lack of trained manpower to cope with new technology changes.

Technology

There is limited availability of technology know-how for resource efficient bricks, as very few technology providers are available in the country. With brick kiln operations in India generally being carried out at the small scale level, individual brick kiln entrepreneurs find it difficult to access such know-how.

Awareness barrier

The present level of awareness of entrepreneurs and end-users on modern technologies (machineries) and building products is low. The benefits from the production of resource efficient bricks - such as energy savings, reduction in top soil consumption and air pollution - are also not well known to entrepreneurs.

Chapter 9

Role of key stakeholders

A large number of stakeholders need to be involved in carrying out the objectives of policy through various actions oriented initiatives. The stakeholders include individual brick manufacturer / entrepreneur, brick industry associations at regional and national levels, financial institutions, technology and equipment suppliers, market and policy enforcement agencies, government (both state and central), NGOs, private and corporate agency, research laboratories, international funding agency as well as the building industry and other end users of the brick products.

Brick kiln manufacturer/entrepreneur

- Individual brick kiln units are expected to take an active role in widespread technology adoption, which would lead to the introduction of new and resource efficient products in the market.
- Implementation of improved firing technology as VSBK for reduction of CO2 emissions.
- Use of Internal fuel such as fly ash, coal dust, rice husk in the process of brick making for consumption of less fuel in firing practices.
- Produce resource efficient brick to reduce the quantity of soil usage.
- Improved kiln operation, particularly by increasing the draught, improving air control and improving fuel feeding practices, the unburnt can be reduced to a large extent.
- Make small improvement in kiln design, construction and operation which would helps in reduced energy consumption.

Brick industry associations

- District level industry associations will facilitate identification of potential brick kiln units who can adopt technologies for production of resource efficient products through accessing finance from commercial banks/ financial institutions.
- Create awareness among brick kiln units on resource efficient products, and interact with policy makers to influencing relevant policies to promote resource efficient products on large scale.

Banks and financial institutions

- Banks and financial institutions would be involved for providing suitable financing mechanisms for technology up gradation.
- Facilitate new and improve technology by offering financial incentives for application of these practices.
- Develop flexible, customized finance products that address the n=eeds of the entrepreneur and facilitate easy repayment.
- Adopt a more flexible and innovative approach in their credit appraisal norms and encourage entrepreneur to take insurance cover.

Policy enforcement agencies

- Policy enforcement agencies can greatly influence the market transformation process by providing support for resource efficient products, which would help in conserving resources and reducing pollution loads.
- Effectively enforce regulatory measures for planned development.

Technology and equipment suppliers

- Technology and equipment suppliers should help for up gradation of traditional technology and adoption of new technology.
- Share information and technologies with the other stake holders and facilitate awareness creation on new, innovative and sustainable methods of brick making.
- Customize alternate technologies for larger application in locally.
- Promote use of resource efficient brick as far as possible and reduced the use of scarce resource, so that the stress on the natural environment is reduced.

State Government

- Prepare policy guidelines related to energy, environment, natural resource and employment.
- Plan long term programmes and short term strategies to tackle problems in brick sector.
- Review the legal and regulatory regime to encourage increasing or improving technology in brick sector.
- State government should take initiative for utilization of energy efficient brick in government sector through govt. agency.
- Encourage partnership between NGOs/CBOs, private sector, PRIs and Microfinance institution.
- Facilitate training programmes for entrepreneur and workers.
- Facilitates research and development activities through appropriate capacity building programmes.
- Ensure large scale dissemination of government schemes and set up structure for accessing them.
- States should ensure availability of their share in schemes sponsored by central govt.
- If required, State government should make efforts to mobilize resources from exclusively for brick sector development.

Central Government

- Take steps to bring in planning, financial, regulatory, institutional and legal reforms.
- Evolve plans, strategies and parameters for optimal use of available resources including land for sustainable development.
- Develop and enforce appropriate ecological standards to protect the environment and provide a better quality of life.
- Promote research and development on innovative building materials, transfer of technology for energy efficient brick sector.

Civil society

- Facilitate exposure and access of innovative technological and institutional solution for brick sector development.
- A very important role of NGOs is to provide Capacity building and training programmes.
- Facilitate Panchayat to access foreign funds /grants and wherever required, provide services for increased effectiveness and greater work efficiency.

Building industry

- Building industry should use resource efficient brick in their construction work.
- Building industry should help for promotion of resource efficient brick, fly ash brick, and also create awareness among all users.

Chapter 10

Recommendations

1. Brick sector should adopt methods and clean technologies which would lead to improvements in quality and fulfillment of need of good quality construction material market.

2. There should be a review of existing policies and formulation of new policies related to energy-resource efficient brick production to create a preferential regime for cleaner brick production technologies.

3. State and Central government should give more attention in technology adoption as well as in energy efficient brick production by setting examples in the use of green building materials in public construction.

4. Financial institutions should be sensitized to support financial needs of credit worthy brick kiln entrepreneurs. Additionally, other modes of financing other then loans and subsidies need to be considered.

5. Steps need to be taken to enhance public awareness on cleaner brick usage; this includes information on various technology choices, details of service providers, financing options and how to avail finance.

6. Since there are a number of stakeholders involved to enable a transformation in the brick sector, multi stakeholder processes for the tracking of the brick sector need to be put in place to undertake short term and long term measures for ensuring the brick sector is put on a low carbon path.

References

Books and Articles

- Heierli, U. & Maithel, S. Brick by Brick: the Herculean task of cleaning up the Asian brick Industry.
- Maithel, S., Vasudevan, N., Johri, R. & Kumar, A. (2001). Pollution reduction and waste minimization in brick making. TERI: New Delhi.
- Iqbal, M. (2006). Bonded labor in the brick kiln industry of Pakistan. The Lahore journal economics, 11.1, 99-119.
- Panigrahi,A., Lokadrusti. Experiences and strategies to address the concerned of seasonal migrant labour in India. Orissa
- Akbar, S. & Ferdausi, S.A. Urban Air Quality, Climate Change, and Development: An IntegratedApproach to “Greening” the Brick Industry in Dhaka, Bangladesh.
- Vasudevan, N. (1994) Accelerating informayion dissemination in small scale brick kiln units through local support and local NGOs..

Web sites

- http://www.bihar.nic.in
- http://www.weinerberger.com
- http://www.vsbknepal.com
- http://www.forest.mtu.edu.com

Annexure 1

Survey Questionnaire

Questionnaire (Brick Kilns/ Fly ash units)				
1	Name of the District-		Name of the Block-	
1.11	Name of the Proprietor			
1.12	Address & Mobile no.			
1.13	Years of Establishment-		Years of Operation-	
1.2	**Operation Hours**			
1.21	Hour per day		Operation days in month	
1.22	Months per year		Reason for variation	
1.3	**Technology Specification**			
1.31	Firing technology			
1.32	Per Day Capacity		Yearly Capacity	
1.33	% of breakages		No .of Shafts/chimneys/machines	
1.34	Single pan/double pan mixer with capacity(FA)			
1.35	Ease of use			
1.36	Process followed-mixing,moulding,drying,firing			
1.37	Per day Diesel Consumption			
1.38	Rated power of motor in KVA or HP			
1.39	Monthly electricity consumption in units			
1.4	Equipment used			
1.41	Technology Supplier			
1.42	How do you know about Technology?			
1.43	Costs of the tech.?			
1.44	Service provided by Technology supplier			
1.45	How much charge by tech. supplier in major machinery Problem ?			
1.46	Why you prefer this technology?			
1.47	Any Suggestions regarding Delivery?			
2.1	**Brick**			
2.11	Dimension		Weight	
2.12	Strength		Brand	

3	**Market & Economics(Costs involved)**			
3.11	No. of brick units in District			
3.12	Total brick production in District P.A			
3.13	Which have greater Demand fly ash/ red brick			
3.14	Majority supply in which location ?			
3.15	How far?			
3.16	% of consumers bricks? Public Urban_____________ and Public Rural			
	Pvt. Small EPs_________, Med EPs_________,Large EPs _________, Individuals For House Construction			
3.17	What is the increase of sales of your bricks compared to last year ?			
3.18	What is the projected growth of sales for next YR.			
3.19	Production Cost Per brick		Selling price Per brick	
3.2	Marketing Strategy adopted(sold through supplier or direct)			
4	**Finance**			
4.11	Total investment		Own investment/ loan	
4.12	If own investment , from whom with amount?			
4.13	Amount of Capital exp.		Own equity amount_______________, Debt amount	
4.14	Amount of Working Capital		Own equity amount ______________ , Debt amount	
4.15	If bank loan , how much amount ?			
4.16	Bank interest rate		Bank branch/Distance	
4.17	Repayment years		Duration	
4.18	Documents submitted			
4.19	Issues faced			
	If you take Debt from informal source what is the interest rate ?			
	What do you prefer financing or own investment			
	Reasons for financing/own investment			
4.2	**Subsidy**			
4.21	If subsidy, why you prefer subsidy?			
4.22	Name of the Scheme		Agency	
4.23	Amount			
4.24	Duration		Process	
4.25	Issues			
5	**Environment & Policy**			
5.11	Do you Know about new technology for savings of energy ?			**YES/NO**
5.12	Do you know about eco-friendly Technology?		**YES/NO**	
5.13	Do you want to Modification Of your existing technology ?			**YES/NO**
5.14	Pollution clearance obtained?		**YES/NO**	
5.15	EM1 Obtained	**YES/NO**	EM2 Obtained	**YES/NO**
5.16	Is the unit registered at DIC-Reasons			
5.17	Any other clearance/ Documents			
5.18	Tax to be paid ?	**YES/NO**	If yes how much ?	
5.19	Service tax or VAT ?			
5.2	Difficulties Faced			

6	**Situation Analysis(past , present, future)**	
6.11	Situation on start	
6.12	situation now	
6.13	Challenges faced in social ,technical & financial aspects	
6.14	Failures	
6.15	Solutions for the failure	
6.16	Future plans	
6.17	Benefits of using clean Tech(VSBK/Fly ash)	
	Employment	
	Better social condition	
	Environment	
	Financial saving	
7.11	Whether you have joined in any brick association or not	YES/NO
7.12	What type of benefit do You get after joined in association-	

Annexure 2

List of entrepreneurs surveyed

Sl.	District	Name of unit	Location of unit	Name of enterpreneur
1	Bhojpur	India itt bhatha	sohadiya	Samim Akhatar
2	Bhojpur	Swastik itt bhatha	Sang pur	Sanjay singh
3	Bhojpur	Super itt bhatha	Danupura	Mahendra singh
4	Bhojpur	Sivam itt bhatha	Jamira	Kamlesh singh
5	Bhojpur	Swastik itt bhatha	Kaim nagar	Ajay kumar singh
6	Saharsa	JBW itt bhatha	Sulindabad	Manoj singh
7	Saharsa	King bricks	Saharsa	Amrit sharma
8	Saharsa	U.K. itt bhatha	Saharsa	Umesh kumar
9	Saharsa	Bam bricks	Sulindabad	Bam yadav
10	Saharsa	KP marka	Sulindabad	Chandrma singh
11	Supaul	GHB itt bhatha	Sokhpur	Jamal khan
12	Supaul	SNS itt bhatha	Belahi	Sekhar kumar
13	Supaul	SBC itt bhatha	Parsarma	Mukesh kr singh
14	Supaul	BBC itt bhatha	Malhi	Balram singh
15	Supaul	SKS itt bhatha	Sokhpur	Satendra singh
16	Katihar	AMBA bricks	Katihar	Deelip kumar jha
17	Katihar	ARSH itt bhatha	Miyapur	Brij narayan panday
18	Katihar	JPC itt bhatha	Bauliya	Jyotsna & Priti singh
19	Katihar	BABA bricks	Boliya gumti	Subash chandra mandal
20	Katihar	DEV bricks	Bangmara	Vijay krishna
21	Madhepura	Shri itt bhatha	Bhantakthy	Arun kumar
22	Madhepura	SNM bricks	Mathahi	Alok kumar
23	Madhepura	Shri laxmi bricks	Mathahi	Prabhat chand gupta
24	Madhepura	Om itt udyog	Savela chauk	Viswa prakash bharti
25	Madhepura	KDB bricks	Mathahi	Duryodhan prasad yadav
26	Patna	Rajan bricks	Sahpur	Naval kisor prasad
27	Patna	Kamal bricks	Chitnava	Hareram singh
28	Patna	Mamta itt bhatha	Chitnava	Ashok kumar singh
29	Patna	UMA bricks	Sahpur	Baldev prasad
30	Patna	Kamal bricks	Sahpur	Sujeet kumar