The Fly Ash Brick Industry in Bihar

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

BIHAR
Bihar State Pollution Control Board

Development Alternatives

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An Analysis

November 2016

SHAKTI SUSTAINABLE ENERGY FOUNDATION

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Bihar State Pollution Control Board

Development Alternatives

Team
Dr. Soumen Maity
Krishna Chandran

An initiative supported by

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Suggested Citation
Maity, S., Chandran, K. The *Fly Ash Brick Industry in Bihar* Development Alternatives, New Delhi

Contact Details
Development Alternatives
B-32, Tara Crescent
Qutub Institutional Area
New Delhi-110016
Tel: 011-26544100

Acknowledgement

The first edition of the Fly ash brick industry in Bihar" was published in 2014. The report has been appreciated by public and private organisations in providing a true analysis of the fly ash brick industry. Since then quite an appreciable change has happened in the sector which prompted the second edition. We hope that this study will be very useful to all concerned.

It would not have been possible for the project team of Development Alternatives to undertake this analysis on the fly ash brick sector in Bihar without the active involvement and assistance of a number of individuals and organizations. We would like to take this opportunity to acknowledge these invaluable contributions.

This study would not have been successful without the support of Shri. Vivek Kumar Singh I.A.S, Chairman; Shri. Chandrasekar I.F.S; Member Secretary and Dr. Naveen Kumar, A.S.O, Bihar State Pollution Control Board who have taken a key interest in the study and have strategically guided and supported us through the entire study. Special thanks are extended to other members of the Task Force including National Thermal Power Corporation, Eastern region and Kahalgaon plant Department of Mining and Building Construction Department (BCD) for their support.

We would also like to thank Mascot Foundation who has supported the team through the entire study. A special mention is due to the brick entrepreneurs without whom the study would not have happened. We thank you for sharing data and insights on your plants and the sector with us. The openness and alacrity with which they shared information and ideas was truly remarkable.

Last but definitely not the least, we would like to thank Shri. Kunal Sharma and Ms. Arshpreet Kalsi, Shakti Sustainable Energy Foundation for their guidance and support at every step.

We do hope that the study will provide an overall status of the fly ash brick sector in Bihar and encourage the establishment of a favourable ecosystem in Bihar to promote the large scale adoption of cleaner brick production technologies like Fly Ash bricks.

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Executive Summary

The Bihar brick industry is currently based on decentralized production activity using energy intensive, resource depleting and highly polluting technologies and production methods with Fixed Chimney Kilns (FCKs) being the predominant firing technology. Fired clay bricks consume around 2-4 million tonnes of coal per year leading to emissions of 4-6 million tonnes of carbon-dioxide (CO_2) per year. The increasing emissions of greenhouse gases from the clay brick making industry contribute massively to the climate change concerns. They also emit sulphur dioxide (SO_2), nitrogen oxides, and suspended particulate matter (SPM).

In order to ensure that the state's economic growth is not at the cost of environment and public health, it is extremely necessary to take initiatives for promoting cleaner brick production technologies and waste management. The optimal solution is to encourage the production and usage of fly ash bricks. This offers an opportunity for productive utilization of waste while preventing the emission intensity of the unit and providing decent jobs to the local community.

The first edition of the Fly ash brick industry in Bihar" was published in 2014. The report provides a true analysis of the fly ash brick industry. Since then quite an appreciable change has happened in the sector which prompted the second edition. The second edition of the study aimed at tracking the growth of the fly ash brick industry by tracking the number of enterprises in the state and assess the status of these units through individual surveys from fly ash brick enterprises across the districts of Bihar to estimate the supply of fly ash bricks and also to assess the quality of bricks produced by these units across the districts of Bihar.

The fly ash brick units tracked during the survey were categorised into functional, non-functional, status unknown and virtual depending on the operational status and other criteria. Analysis on the survey results revealed that despite the increase in the total number of units compared to 2014, the total number of functional units in the state was found to be 46 and the other units tracked were found to be non-functional due to lack of demand for the bricks produced by these units. The survey team were unable to trace some of the units identified in the initial list due to non-availability of accurate information.

The rated production capacity of the total number of units (129) as per the initial list identified through data collected from sources such as Bihar State Pollution Control Board (BSPCB), members of the fly ash brick association and other secondary sources is estimated to be 300 million bricks annually. Running at rated capacity they are projected to save 67,000 tonnes of coal and 210,472 tonnes of CO_2 and 914,400 tonnes of soil saved in 2016. This represents, on a per brick measurement, a 100 percent saving on directly burned coal, a 98.1 percent saving on CO_2 , and a 100 percent saving on soil, by fly ash, over clay, per brick.

Despite the initial success of fly ash bricks in Bihar, further steps need to be taken in order to help supplement the demand for (clay) bricks, which are produced in over 6,000 kilns in Bihar. Fly ash brick makers face several barriers to entry, including a lack of market demand, negative mindset regarding fly ash bricks, lack of fiscal incentives, problems with fly ash sourcing, and lack of regulation, leading to market uncertainty and awareness. If Bihar is to grow its fly ash brick industry into one that occupies a significant part of the market share and provides significant coal and CO_2 savings, it will need to implement policies that can facilitate the improved supply of fly ash bricks, and augmenting the demand through quality assurance of the bricks produced.

Policy push is a major driver for accelerating the uptake of the technology. The concerns of the government regarding the management of fly ash is reflected in the policies and schemes formulated by the government. However, better enforcement of these policies is required. The state needs to incentivise entrepreneurs to set up more units. Market is the most important factor in facilitating a shift from the conventional resource inefficient technologies to fly ash brick technology. Increasing brick demand presents an opportunity to shift towards low carbon and energy efficient fly ash brick technology.

Other drivers include heightened awareness among the entrepreneurs as well as consumers, ease of access of technology and the active engagement of civil society organisations in promoting the technology. However, a few barriers like weak enforcement of policies, lack of market demand of fly ash bricks, lack of access to finance and the lack of quality control needs to be addressed to popularise the use of fly ash bricks in other parts of the country.

Key Messages

The Bihar brick sector is dominated by the production of fired clay bricks which consume 2-4 million tonnes of coal per year leading to emissions of 4-6 million tonnes of carbon-dioxide (Co_2) per year contributing massively to the climate change concerns.

90 percent of the brick making soil is procured from agricultural land with only 10 percent 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.

The usage of fly ash bricks offers an opportunity for productive utilization of waste while preventing reducing the emission intensity of the unit and providing decent jobs to the local community.

Field study conducted in Bihar to understand the present scenario of the fly ash brick industry indicate that the sector has seen an upsurge of fly ash brick production units in the last four years. The number of fly ash brick enterprises in the state has grown from 25 in 2014 to 129 in 2016.

Analysis from the survey reveal that only 46 out of the 129 fly ash brick enterprises remained functional units (currently in operation) while the rest of the units were either non-functional or shutdown due to lack of market demand

Fly ash brick makers face several barriers to entry, including a lack of market demand, negative mindset regarding fly ash bricks, lack of fiscal incentives, problems with fly ash sourcing, and lack of regulation, leading to market uncertainty and awareness.

Promotion and implementation of policies such as preferential procurement of fly ash bricks for use in public construction along with quality assurance and control system in addition to the incentives to entrepreneurs is a major driver for the accelerating the uptake of the technology.

Other drivers such as heightened awareness among the entrepreneurs as well as consumers, ease of access of technology and the active engagement of civil society organisations can play a crucial role in the market uptake of fly ash bricks chartering a Low carbon development pathway for the state of Bihar.

Highlights

Task Force on accelerating 'Cleaner Production Systems'

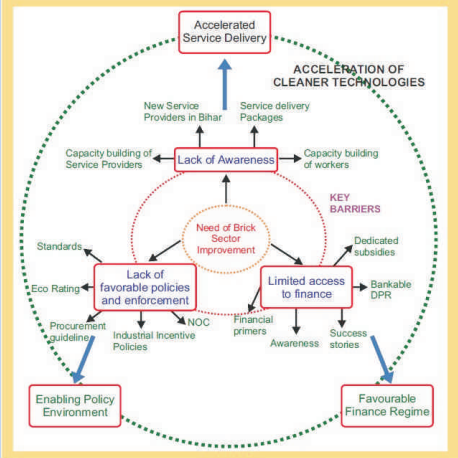
Workshop on Cleaner Brick Production Technologies- Supporting Bihar's Initiative Towards a Low Carbon Economy was organised by Bihar State Pollution Control Board and Development Alternatives in association with Shakti Sustainable Energy Foundation on the 6th of December 2012 at Hotel Pataliputra Ashok, Patna

Address by Chief Guest, Shri Sushil Kumar Modi, Hon'ble Deputy Chief Minister, Bihar

Shri. Dipak Kumar Singh
Secretary
Dept. of Environment and Forests

Task Force on Clean Building Materials

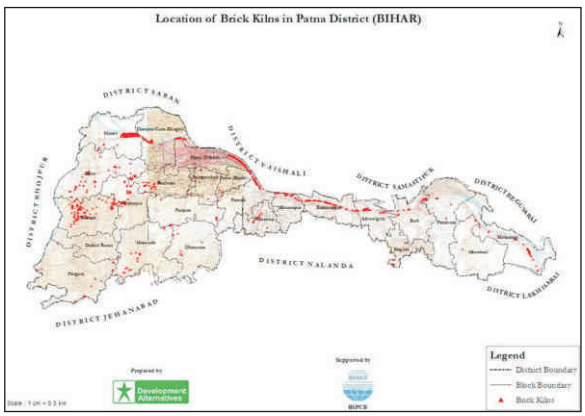
The Government of Bihar, in association with DA has been actively promoting the adoption of low carbon and resource efficient technologies especially fly ash brick technology in the state. An Inter Departmental Task Force on Accelerating 'Cleaner Production systems' in the building material sector was setup in 2012. The Task Force aimed to streamline the efforts of the various Government departments involved. Convened by the Bihar State Pollution Control Board, its members include the Department of Environment and Forests, Department of Building Construction, Department of Industries and other organisations like National Thermal Power Corporation (NTPC).



The Mandate of Task Force is to recommend, monitor and advise on accelerating production, availability, acceptability and use of low-carbon technologies and building materials in Bihar. The major objectives are:

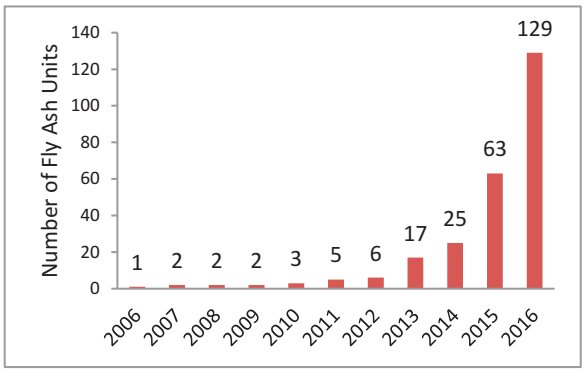
- To ensure savings of natural resources like coal and soil
- Reduce pollution from the operation of existing technologies

DA provides technical and secretarial support to the Task Force. Over the last two years, the Task Force has emerged as a key decision making venue where policy ideas are discussed and vetted.



Zoning of brick kilns

Due to increased infrastructure needs in the Patna district, the demand for bricks has immensely increased. As a result, there has been an upsurge in number of red brick kilns on the either side of Ganga. Realising the environmental implications, DA has conducted an inventorisation of the red brick kilns in the Patna district of Bihar. The aim of the initiative is to assess the damage to the environment. It aims to develop a Decision Support System to assess and mitigate further damage to the environment.



The Fly Ash Brick Sector of Bihar

With the current and future increase in the production of fly ash in Bihar, 4389 fly ash units can be set up. The potential impacts of these fly ash units are:

- Annual production of fly ash bricks – 10.53 billion
- Annual savings of coal – 31.6 million tonnes
- Annual savings of carbon emissions – 7.27 million tonnes
- Annual savings of fertile top soil – 31.6 million tonnes

Policy Interventions

Through their policy interventions along with awareness generation activities, Task Force have managed to:

- Enhance the rates of fly ash bricks in the state Schedule of Rates (SoR)
- Streamline the process of procurement of fly ash from NTPC, Kahalgaon.

Other intervention areas include:

- Development of a rating system for fly ash bricks
- Use of fly ash bricks in public construction
- Inclusion of fly ash brick production technology in the thrust area of Bihar Industrial Incentive Policy 2011
- Exemption of cleaner brick production technologies from the list of industries ineligible for incentives in the Bihar Industrial Incentive Policy 2011
- Amendment of mining royalty structure on the basis of production capacity and soil use of different brick production technologies
- Relaxation in the citing criteria of brick kilns owing to low pollution levels of these technologies

Workshop on Roadmap Towards Accelerated Adoption of Fly Ash Brick Industry in Bihar, 23rd of November 2016 at Hotel Pataliputra Ashok, Patna

Sri Vivek Kumar Singh, IAS
Chairman, BSBCP & Principal Secretary
Department of Environment & Forest, Govt. of Bihar

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Introduction and Background

1

1. Introduction

1.1 Background

Building materials, especially bricks, form the backbone of the construction sector. India is the second largest producer of bricks after China. With over 150,000 brick kilns, India produces an enormous 150-200 billion bricks annually . However, the Indian brick sector is dominated by resource and energy inefficient technologies like Fixed Chimney Kilns (FCKs) and clamps with a very little signs of change to more energy efficient technologies. The clay brick sector consumes nearly 35 million tonnes of coal annually , and its total carbon-dioxide (CO_2) emissions are estimated at 41.6 million tonnes, accounting for 4.5 percent of total greenhouse gas (GHG) emissions from India. In addition to coal, the red brick sector also consumes approximately 350 million tonnes of fertile top soil. Some of the major brick producing states in India include Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal.

Though alternative technologies such as fly ash bricks, AAC blocks, compressed earth blocks (CEB) and concrete blocks are also being used, they only occupy a tiny market share. However, there has been a relative growth in the alternate building materials market over the last ten years.

1.2 An overview of Bihar brick sector

The entire brick industry of Bihar is based on burnt clay bricks with very sporadic instances of any alternatives. With around 6,000 kilns, the state of Bihar produces approximately 18 billion bricks per year. Currently, the brick sector is growing at the rate of 9 percent per year. Fixed Chimney Kilns (FCKs), which are resource and energy intensive, are the predominant technology in the state. They consume between 2 and 4 million tonnes of coal per year leading to emissions of 4 to 6 million tonnes of carbon-dioxide (CO_2) per year. Emissions of particulate matter and SO_2 cause serious health issues, especially those related to the respiratory system.

Aside from coal, brick production in Bihar and most other states uses fertile top soil. Around 30 million

cubic meters of soil are consumed per year, 90 percent of which is procured from agricultural land . The loss of fertile land translates to the loss of area equivalent to Patna every 3 years. The usage of agricultural soil in brick making will adversely affect the food security of Bihar, a state already affected by floods and droughts.

Brick production is slated to increase in the state, in order to address the urbanisation and growth demands especially the housing shortage and reconstruction activities due to the impacts of natural disasters. Current practices will only worsen the impacts on the environment. Therefore, it is necessary to accelerate the adoption of cleaner brick production technologies.

The usage of fly ash for the production of bricks presents a lucrative opportunity to reduce the negative environmental impacts of clay brickmaking, while also mitigating the land used in the disposal of fly ash, which is produced during coal burning at power plants.

1.3 Environmental footprint of the red brick sector in Bihar

The production of red bricks in the state is the major cause for air pollution and increased CO_2 emissions. Several initiatives have been taken from time to time to regulate these industries to control the negative impacts of such unsustainable production practices. For example, the recent notification by the Bihar State Pollution Control Board (BSPCB) has set an example to the neighbouring states by issuing an order asking all brick kilns in Patna and adjoining districts to upgrade to cleaner technologies and the order also states that the new licences to set up kilns in the state will now be issued only if the owners are adopting to clean technologies.

In addition to consumption of fossil fuel, approximately 30 million cubic metres of soil is consumed by the sector per year. 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. This type of uncontrolled soil use will lead to a famine like situation in the near future if alternate methods are not adopted accordingly.

In order to ensure that the State's economic growth is not at the cost of environment and public health, it is extremely necessary to take initiatives for promoting cleaner brick production technologies and waste management. The optimal solution is to encourage the production and usage of fly ash bricks. This offers an opportunity for productive utilization of waste while preventing the emission intensity of the unit and providing decent jobs to the local community.

1.4 Conventional red brick production – Issues and Challenges

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

Environmental issues - From the environmental point of view, the brick industries have been exacerbated by cheap access to resources such as soil, coal, biomass materials and labour. This results in irreversible environmental damage in terms of loss of top soil, continued wastage of energy which is a valuable national resource and damage to property and crops from high air pollution.

Socio-Economic issues - The workers in the brick industry are subjected to extreme working conditions and poor remuneration. Currently in India, brick manufacturing is a labour-intensive sector, with crude techniques causing considerable worker drudgery. They are also exposed to high concentrations of Respirable Suspended Particulate Matter (RSPM), during monitoring and regulating the fire, as the furnace chamber is covered with ash (ash acts as insulator). Also, the seasonal nature of brick production generates employment for a limited period of six - seven months in a year. Majority of the workforce has no option, but to engage generally as agricultural labourers for the rest of the year.

Lack of financial regime and awareness to alternate technology solutions - There is 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 for 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. 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.

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, business opportunities and kiln management. There is also a lack of trained manpower to cope with new technology changes.

2. The study

2.1 Objectives

The objective of the study is to:

- Track the total number of fly ash units in the state and estimate the supply of fly ash bricks
- Assess the quality of fly ash bricks produced by these units across the districts of Bihar

The survey aimed at identifying the total number of fly ash units in Bihar from the data collected from sources such as Bihar State Pollution Control Board (BSPCB) and members of the Fly ash brick association. A list of entrepreneurs who have been granted a No Objection Certificate (NOC) was obtained through the Bihar State Pollution Control Board (BSPCB). The target was to survey all the 129 entrepreneurs from the consolidated list prepared.

2.2 Methodology

The methodology aimed to gather resources efficiently and quickly from entrepreneurs in the field.

2.3 Survey design

A detailed questionnaire was designed in order to collect basic information about fly ash brick entrepreneurs in Bihar. The core idea was to gather a sense of the location, circumstances of establishment, background of the entrepreneur and details regarding the production process and output. The following categories of information were collected:

- Details of the fly ash brick making unit
- Financial details
- Service providers
- Production processes
- Consents obtained
- Details of fly ash sourcing
- Marketing efforts
- Support sought from the government
- Quality of the bricks

2.4 Data collection

Once the survey was designed, actual data was collected from the field. The list of entrepreneurs obtained from BSPCB and the members of the fly ash brick association was consolidated. The data was collected through the one to one surveys and through observation during the site visits. In addition, brick samples were collected and tested for compressive strength and water absorption as per IS 12894:1990 at a NABL accredited testing laboratory named Global Testing and Research Laboratory (GTRL), Patna. The testing has been conducted at two phases where brick batches from 30 fly ash enterprises were tested during the Phase I and the Phase II testing involved 17 fly ash brick batches collected from the other districts during the tracking study.

2.5 Analysis and report

The survey analysis covered the current status of Bihar's fly ash brick industry with an emphasis on the following:

- Current technology used
- Trends in business
- Financial and market trends
- Quality of the products
- Key concerns of the stakeholder

2006

Figure 1a: Google earth map of Patna region showing Fixed Chimney Kilns (FCK) circled in red (2006)

2016

Figure 1b: Google earth map of Patna region showing Fixed Chimney Kilns (FCK) circled in red (2016)

Overview of Fly Ash Brick Industry of Bihar

2

1. Current status of fly ash brick units

The Bihar brick sector has seen an upsurge of fly ash brick production units in the last four years. Initial survey list gathered from BSPCB and fly ash brick associations totalled to 129 units spread across various districts. As anticipated during our survey in 2013, the numbers of fly ash brick enterprises have surged from 25 in 2014 to 129 in 2016 as shown in figure 2.

The survey aimed to track these individuals units from the initial list prepared to estimate the supply of fly ash bricks and assess the quality of bricks produced by these units in the state. The fly ash brick units tracked during the survey were categorised into functional, non-functional, status unknown and virtual depending on the operational status and other criteria as defined in table 1.

Analysis on the survey results reveal that only 46 out of the 129 fly ash brick enterprises remained functional, out of which most of them are found to be in the district of Patna. The number of non-functional units counted to 34 which have completely shut down their

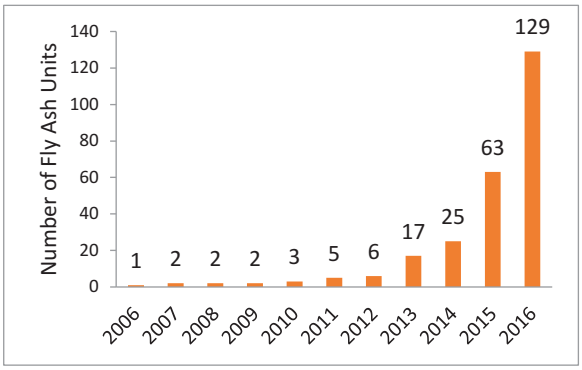

Figure 2: Number of fly ash brick units

operations due to lack of demand for their bricks produced in the market. It is also to be noted that a few of these non-functional units have moved to other lines of business such as manufacturing of paver blocks. 31 units during the survey were untraceable due to the non-availability of proper information such as location and contact details. Physical presence of 18 units was not found at their registered addresses which were defined as virtual units in this analysis report. The status of the fly ash brick units in Bihar by category is shown in figure 3.

Table 1: Category and definition of surveyed fly ash brick units

Category	Definition
Functional	Enterprise currently in operation and continue the sale of bricks throughout the year (or) Operating based on the demand of fly ash bricks in the market
Non functional	Plant closure or complete shutdown of operation
Status unknown	Untraceable due to unavailability of information
Virtual	No physical presence found on the location registered

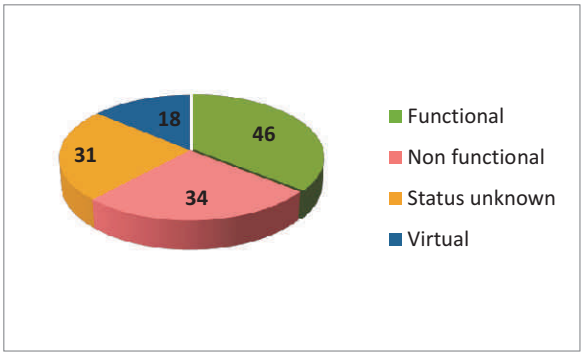

Figure 3: Status of fly ash brick units by category

Patna, Bhagalpur, Begusarai and Muzzaffarpur were identified to be the four major fly ash brick producing clusters of Bihar. Majority of the fly ash brick units in the state are situated in the region surrounding these clusters. The operational status of enterprises in 4 major clusters is shown in figure 4.

The number of units in Patna cluster adds to 57 units, contributing a share of 44% of the total number of fly ash brick units in the state. The cluster also hosts the maximum number of functional units (17) compared to other major fly ash brick clusters. The number of non-functional units in Bhagalpur is found to be very less and the reason assumed is the proximity to the Kahalgaon thermal power plant which gives an easy access to sourcing fly ash with reduced distance of transportation. An equal balance of functional and non-functional units is found in the Begusarai cluster with no specific reason identified for the operational status apart from the lack of demand. Despite being close to Kanti thermal power plant, the Muzzaffarpur cluster has the least number of functional units where the number of non-functional units totalled to 4 out of the 6 units in the cluster.

These units form five major clusters around the power plants. The clusters are defined within a 100 km radius of the nearest thermal power plant. The cluster and the nearest power plant location can be seen in figure 5. The present fly ash generation potential from the operational power plants is estimated to be 10.6 million tonnes and this is expected to increase further to 22.57 million tonnes as more power plants will become operational by the year 2020.

a. NTPC, Kahalgaon, forming the Bhagalpur cluster

b. BTPS Barauni, forming the Begusarai cluster

c. MTPS, Kanti, forming the Muzzaffarpur cluster

d. NTPC Barh, forming the Patna cluster

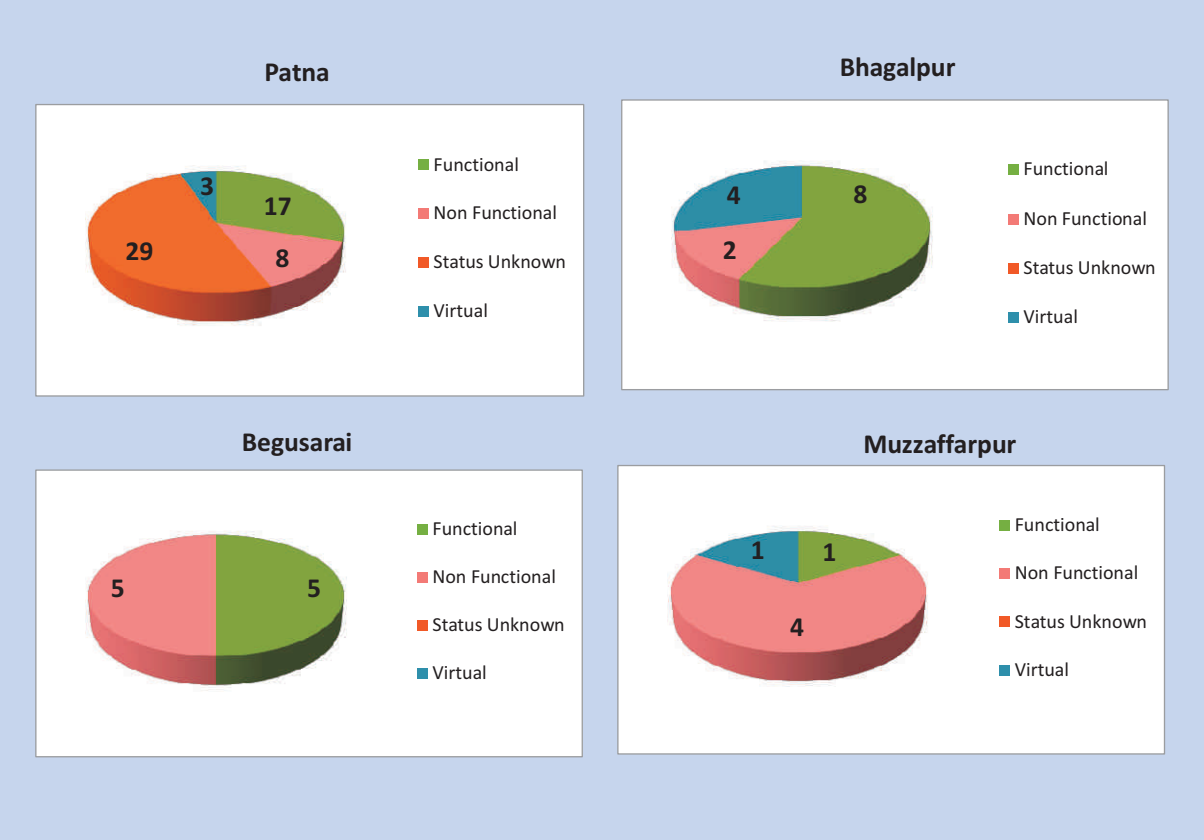

Figure 4: Status of major fly ash brick clusters

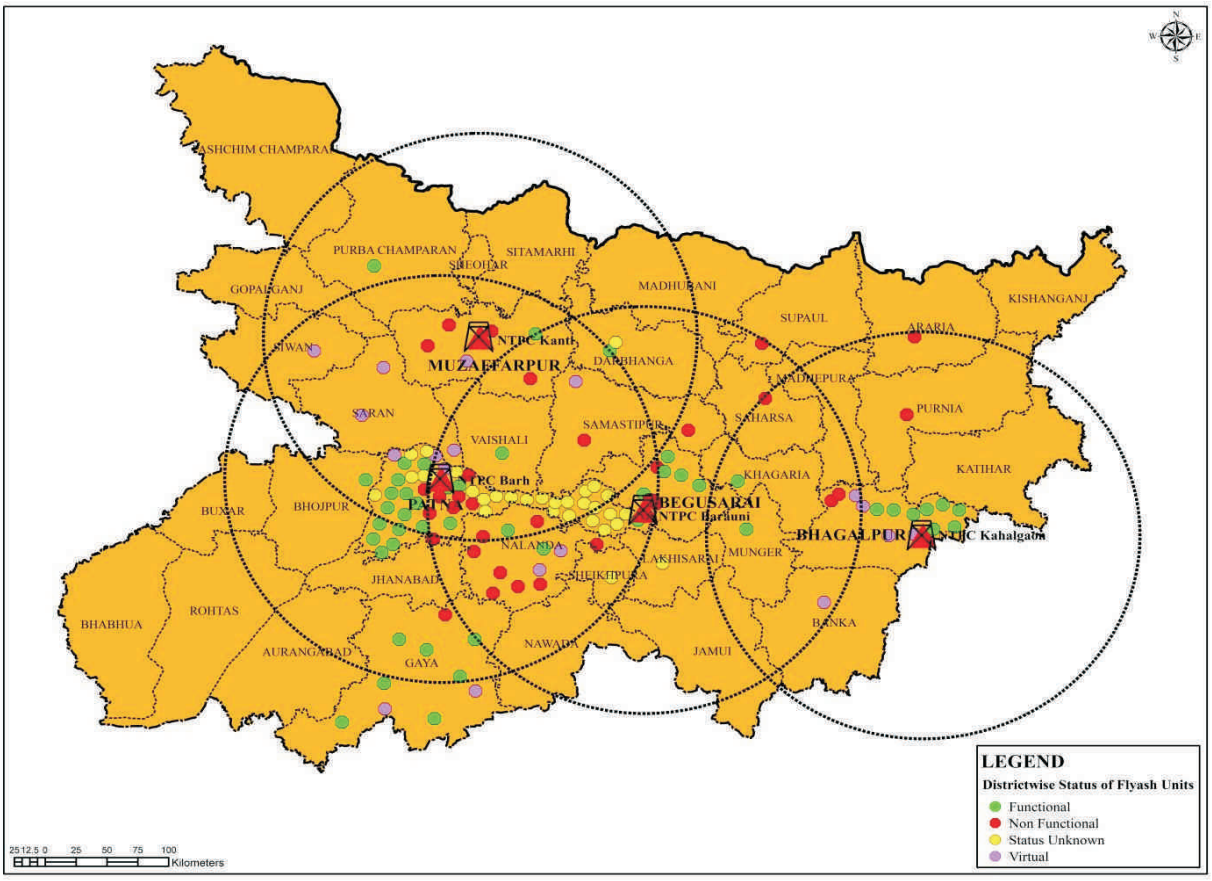

Figure 5: Major fly ash brick clusters and thermal power plant location

2. Fly Ash capacity in Bihar

The cumulative capacity of the fly ash brick units in the state has increased progressively since 2006. With the increase in number of fly ash brick units across Bihar, the production capability of the state is projected to be approximately 300 million bricks per year. Although the production capacity found to be high on one end, the survey results reveals that the actual production capacity to be one third of the total production capability due to number of units that are non-functional (shutdown) due to the lack of demand for the bricks produced.

It is also worthwhile to note that only the clusters of Patna and Bhagalpur, Begusarai and Nalanda contribute a major share towards the total production of fly ash bricks in the state.

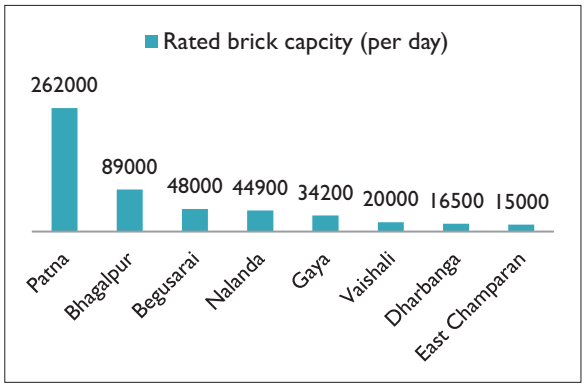

Figure 6: Fly ash rated capacity by districts in Bihar

3. Size of the enterprises

The fly ash brick units traditionally fall under the SME category of industries. The Ministry of Micro, Small & Medium Enterprises (MSME) defines the size of enterprises by virtue of investment. Figure 7 shows the distribution of the surveyed units in this classification. The size of each unit was determined by the capacity of the unit. Equipment and machine market prices were used to build an estimate of the investment that each entrepreneur made in his/her business.

Hence, from Figure 7, it is clear that the size of units in Bihar varies, and the micro enterprises are more popular than small enterprises. As can be seen, micro enterprises hold 80 percent of the market.

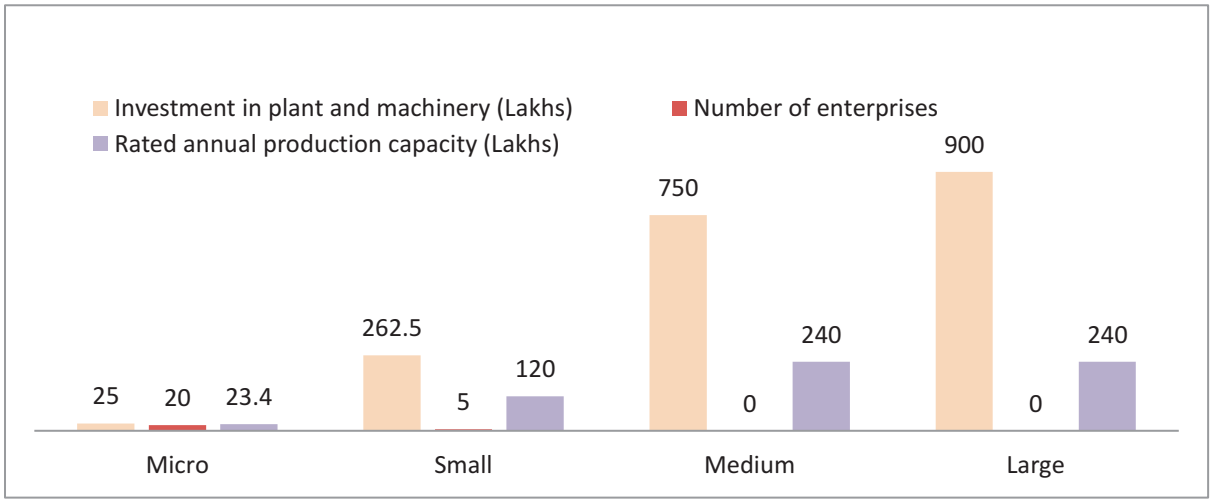

Figure 7: Brick enterprises in Bihar as classified by size

Name of the power plant	Operational status	Installed capacity	Generation of flyash (MT)	Fly ash utilised (MT)	Fly ash utilised (%)
Muzaffarpur	Active	220 MW	0.28	0.05	18.99
Kahalgaon	Active	2340 MW	5.64	1.68	29.87
Barh	Active	1320 MW	0.27	0.01	3.65
Barauni	Active	220 MW	0	0	0

Table 2: Status of thermal power plants in Bihar

4. Fly Ash generation and utilisation in Bihar

Over the years, fly ash utilisation across NTPCs has reached to about 55.69% (102.54 MT) in the year 2014-2015 as compared to less than 10% (6.6 MT) of the ash generated during the year 1996-97 (CEA, 2015). The Ash Utilisation Division (AUD), set up in 1991, strives to derive maximum usage from the vast quantities of ash produced at its power stations. The ash is now being looked at as a commodity that could generate wealth for the company in the long run. The AUD proactively formulates policies, plans and programmes for ash utilisation. It further monitors the progress in these activities and works for developing new segments of ash usage. The fly ash generated at NTPC stations is ideal for use in the manufacture of cement, concrete, concrete products, cellular concrete products, bricks, blocks and tiles.

The quantity of fly ash generated from NTPCs in Bihar is 6.2 million tonnes with an utilisation rate equivalent to 28 percent. The fly ash generation in the state is progressively set to increase in the next five years due to new power plants commencing operation by 2018 to 2020. Currently, there are only a few power plants operational in the state. NTPC Kahalgaon has an installed capacity of 2340MV, generating 5.6 MT of fly ash every year. The installed capacity of power plants with details on the operational status, fly ash generation and utilisation rates can be found in Table 2.

Fly Ash: The finer, thinner ash that is produced in the burning of coal is known as fly ash. This is the ash collected from the top of chimneys in thermal power plants, and is the norm for usage in fly ash bricks. Fly ash is best used in bricks which require its thin particle size and fineness.

Pond Ash: Pond ash or bottom ash contains larger particles, and includes unburnt coal particles. Because of the larger particle size, particles of pond ash are generally heavier than particles of fly ash, and thus change the quality of the bricks in which they're used. Pond ash is currently used for agriculture and land development, rather than for bricks. It can also be used in mortar and concrete. Research is underway regarding minimizing strength loss due to high molecular size and finding the best method of utilizing pond ash for bricks.

5. Use of Fly Ash in brick production

Fly ash is produced during the combustion of coal in thermal power plants. It is suitable for use as raw materials in various building materials, and is particularly suitable for use in bricks. Fly ash bricks are made from fly ash, lime, gypsum and/or cement. There are no emissions of GHG, since coal is not burnt during the production of fly ash bricks. Fly ash consumes less mortar during construction. Additionally, it conserves fertile top soil since no soil is used in the production of bricks.

Of the four power plants in the state, the National Thermal Power Corporation (NTPC) Kahalgaon produces five million metric tonnes (MT) of fly ash per annum, which is collected and available for use in brick making However, the government is investing in more thermal/capacitive power plants, with plans of expanding capacity by approximately 12,000 MW in the next five years. With the increase in the capacity of thermal power plants, the fly ash brick entrepreneurs will be able to acquire almost 4.5 million tonnes of fly ash for free, assuming a 20 percent usage of the free fly ash availability.

Modes of fly ash utilisation

The opportunity is ripe for the promotion of fly ash brick technology, especially in lieu of the upcoming thermal power plants. Recognising this, several entrepreneurs have set up fly ash brick production units in Bihar. More than 100 units have been

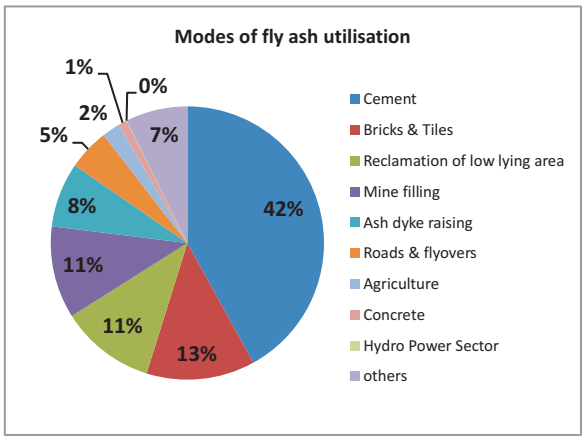

Figure 8: Modes of fly ash utilisation

established between 2006 and 2016. However, the market uptake of such bricks is being hampered by concerns regarding the timely supply and quality of these bricks. Similar concerns were raised by government departments involved in construction. It is necessary to address these concerns to ensure the further dissemination of this technology. Realising the need to alleviate such concerns, Development Alternatives decided to track the fly ash brick production and consumption in the state. The data on fly ash utilization received from Thermal Power Stations/Power utilities for the year 2014-15 has been analysed to ascertain the modes in which fly ash was utilized and the quantity utilized in each mode. The modes in which fly ash were utilized during the year 2014-15 along with utilization can be found in the figure 8.

Fly ash can be gainfully utilised in various way and research studies show that the quality of fly ash produced at NTPC's power stations is extremely good with respect to fineness, low unburnt carbon and has high pozzolanic activity and conforms to the requirements of IS 3812 – 2003 - Pulverized Fuel Ash for use as Pozzolana in cement, cement mortar and concrete. The fly ash generated at NTPC stations is ideal for use in the manufacture of cement, concrete, concrete products, cellular concrete products, bricks/blocks/ tiles etc. The important areas for this utilisation are cement industry, bricks industry, road embankment, mine filling, land development and ash dyke raising. It is also a source of micro and macro-nutrients in agriculture.

NTPC is also looking at innovative ways to utilise the fly ash for development of new segments through partnerships with leading research institutions and organisations. Use of fly ash in the manufacture of pre-stressed railway concrete sleepers is demonstrated in association with IIT Kanpur. In case of mine filling, a research study is being done by the Central Institute of Mining & Fuel Research (CIMFR), Dhanbad for taking up technology demonstration project for random filling of ash from NTPC Ramagundam with Mine over Burden (MOB) at Medapalli Mines.

6. Source of Fly ash

There are only 4 major sources of fly ash in Bihar. These are all existing thermal power plants in Kahalgaon, Muzzaffarpur, Barh and Barauni.

Out of the total 46 functional units surveyed during the tracking study, 15 units source fly ash from NTPC, Kahalgaon. Surprisingly, entrepreneurs in the Patna region are also sourcing fly ash from NTPC, Kahalgaon, which is almost 280 km away. The fly ash is transported to the location of the units through authorised transporters, who pack the fly ash in bags and ship it in trucks.

The lack of easy access to fly ash from NTPC Kahalgaon was a major issue for entrepreneurs. Consequently, the NTPC revised its procurement process so that just three forms (an application form, an undertaking, and a declaration of excise duty exemption) have to be submitted in order to acquire fly ash. After the submission of the required documents and a site inspection, NTPC signs an agreement with the entrepreneurs.

After the revision of the procurement process, the entrepreneurs source fly ash at frequent intervals, depending on their sales; Most of the enterprises source fly ash on a monthly basis. The amount of fly ash procured varies with the size of the enterprise and the demand for the product; a vast range of 10 to 2300 tonnes of fly ash per unit per month are currently sourced.

7. Technology trends

7.1 Technology and service providers

A host of technology service providers provide equipment and machinery for the production of fly ash bricks. TARA Machines and Tech Services Pvt. Ltd. (TMTS) and Neptune and Ashtech Coimbatore provide equipment and services and hold 20 to 30% of the market shares. Other technology service providers include B&B machines, MEC Coimbatore, Bharat Hydraulic, Orbit Intelligent Engineering, Shree Hari Engineering, Navkar Engineers, Speed Sales, Shanthi industries and Ashtech. The majority of these service

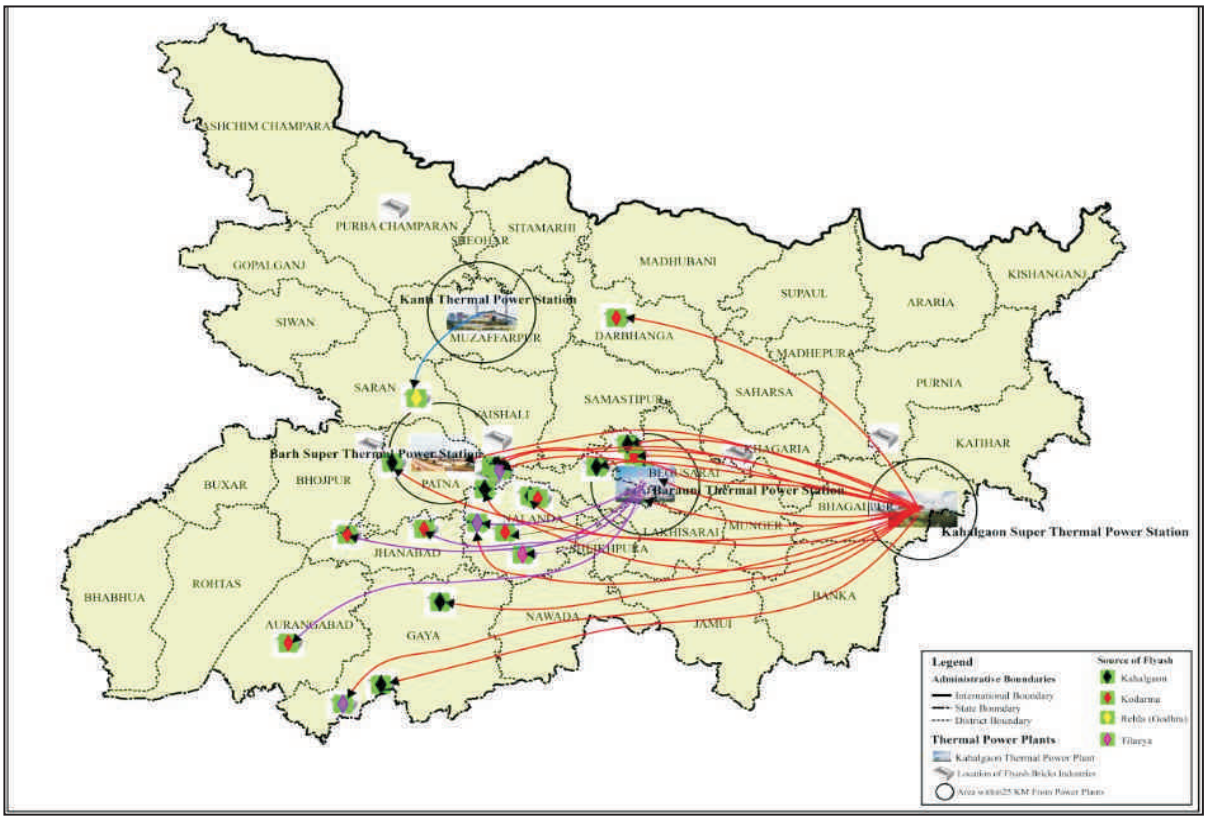

Figure 9: Sourcing patterns of fly ash enterprises from NTPC's in Bihar

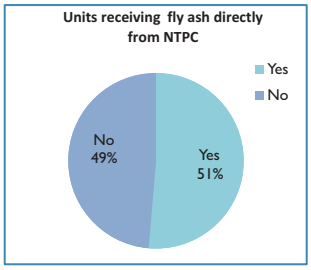

Figure 10 : Units receiving fly ash directly from NTPC

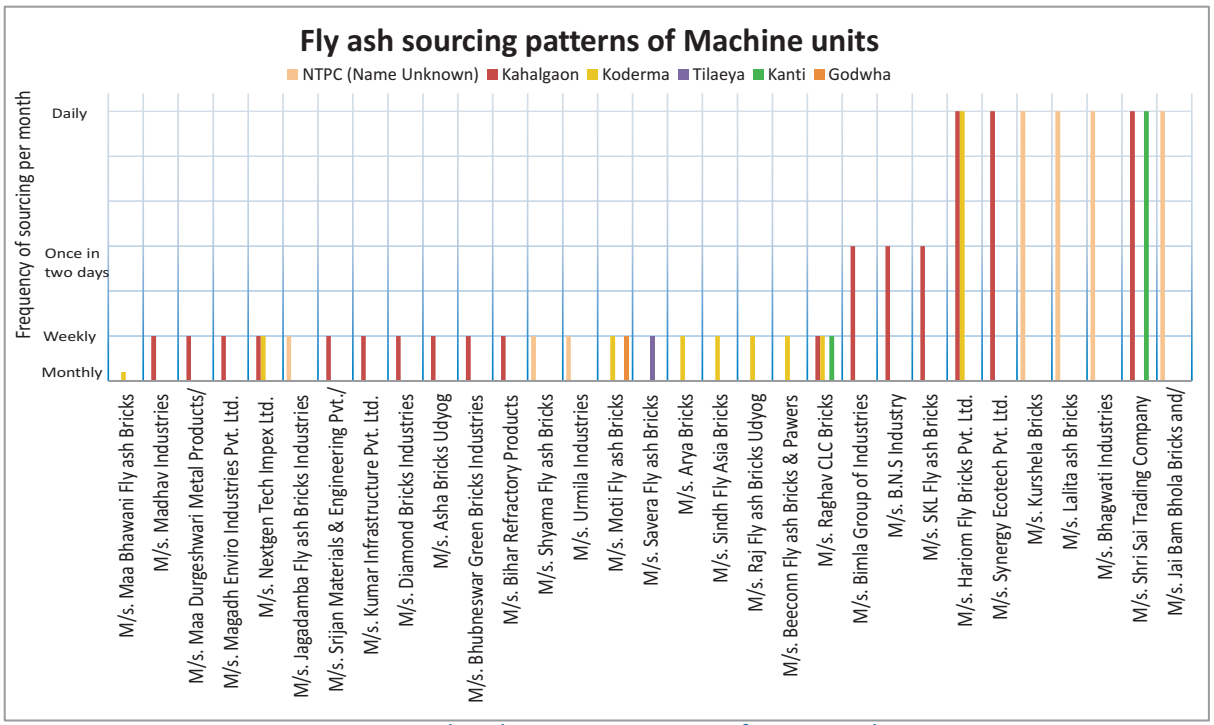

Figure 11 : Fly ash sourcing pattern of units in Bihar

providers also provide troubleshooting services. However, during the survey it is noted that a few entrepreneurs were not satisfied with their after sales service.

Analysis of the survey results revealed that technology providers with in the state and other unknown players hold a significant percentage (30% – 40%) of the market share including service and maintenance of the machines.

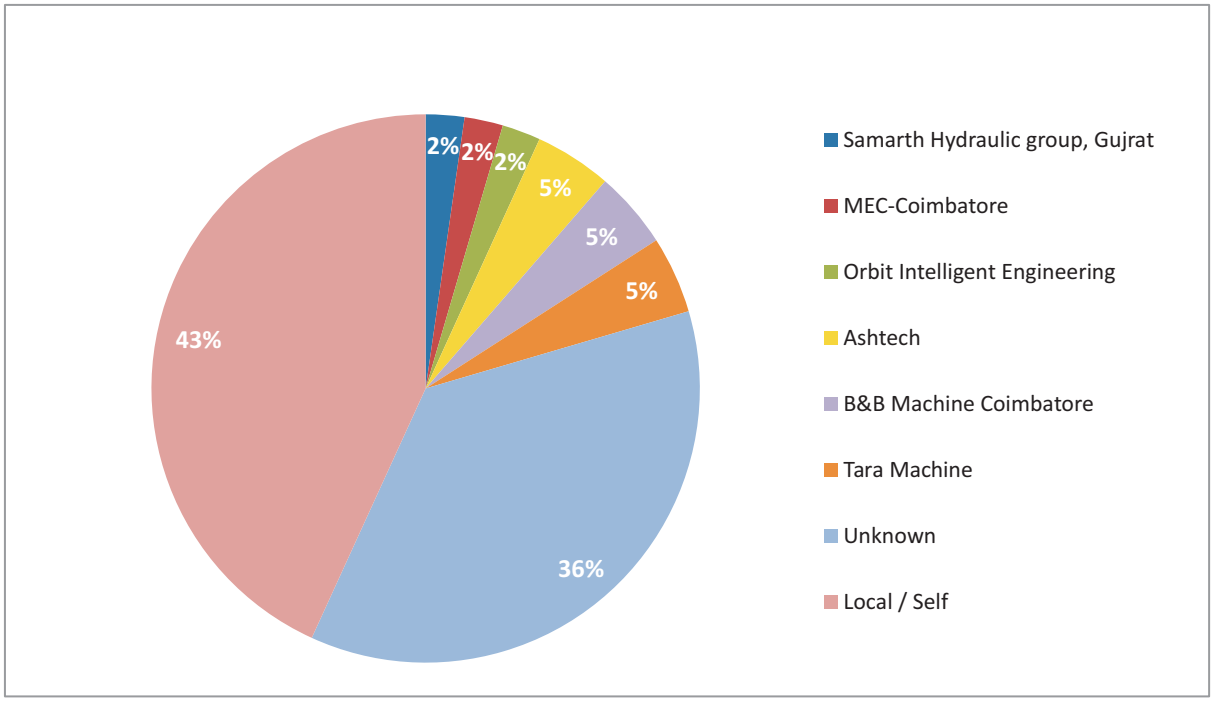

Figure 12: Technology providers share towards service and maintenance

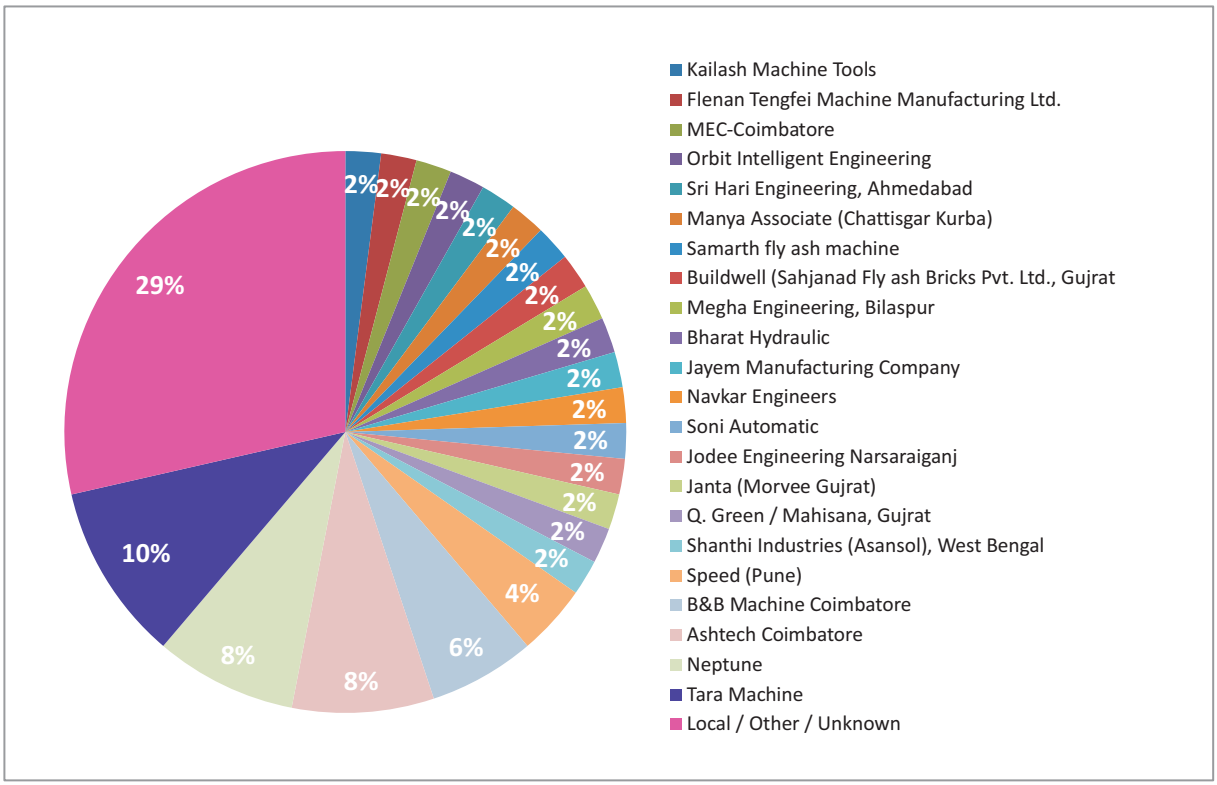

Figure 13: Market share of technology providers

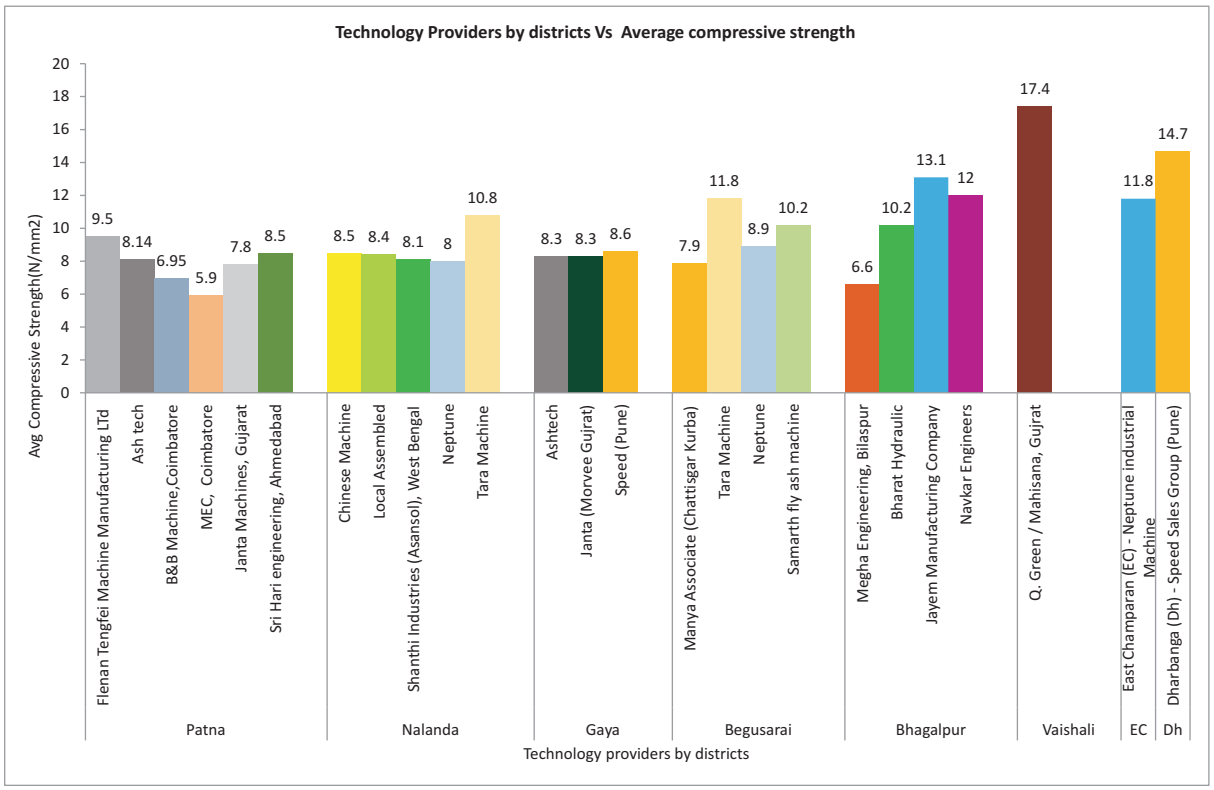

Figure 14: Technology providers and their average compressive strength

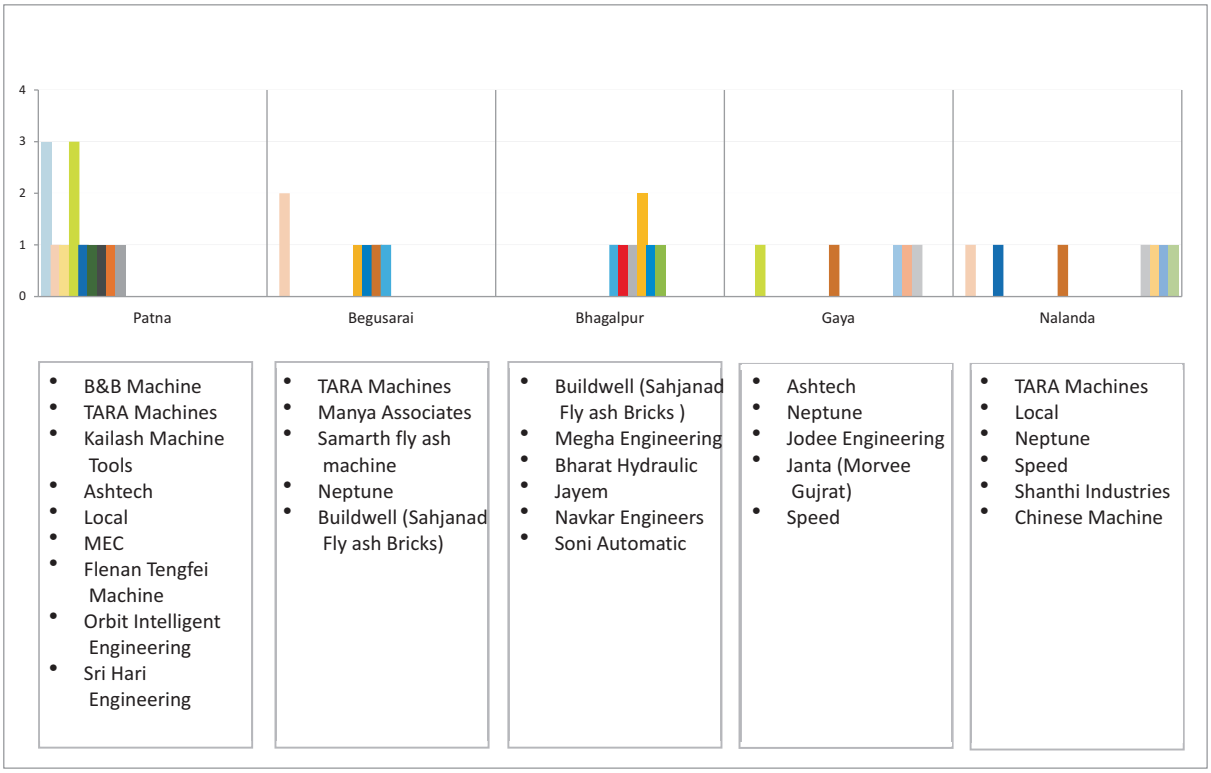

Figure 15: Technology providers in major districts

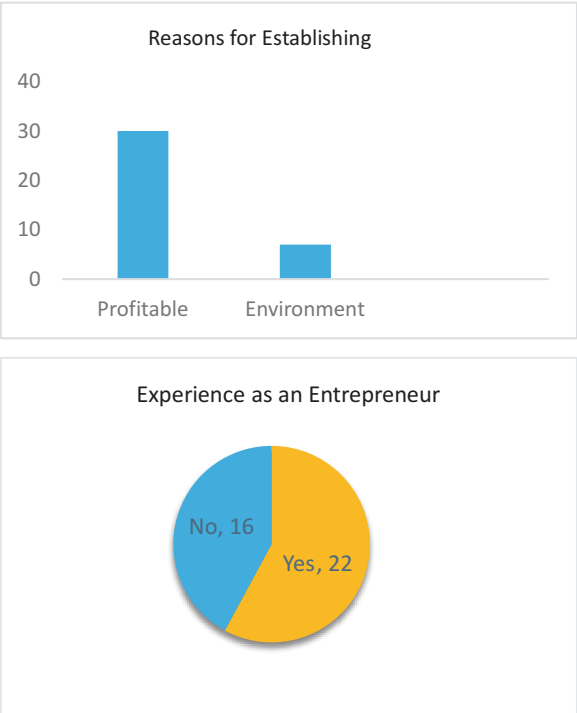

Figure 16: Major reasons for setting up fly ash brick enterprises

8. Business trends

Entrepreneur profile

Majority of the entrepreneurs had previous business experience and 22 percent of entrepreneurs reported that their fly ash unit was their first business venture. Amongst them, 40 percent had experience in the construction sector. While the sector itself is new, it is also attracting those with expertise in construction and engineering.

The major reasons for setting up new fly ash units were cited:

- Profit through business
- Positive impact on the environment

The majority of those surveyed cited profitability of the business as the reason to establish new units. 60 percent of entrepreneurs viewed fly ash brickmaking as a lucrative business opportunity. A few entrepreneurs also referred to the environmental and social benefits as the reason for setting up new units.

Several entrepreneurs mentioned that they saw the potential for success in the business model, and were attracted to the idea that fly ash bricks were a relatively new technology that hadn't been widely seen on the market. Additionally, some entrepreneurs mentioned that the recent law requiring new red brick kilns to switch to cleaner technologies to attain environmental clearance was hindering them from setting up red brick kilns, thus encouraging them to set up fly ash units.

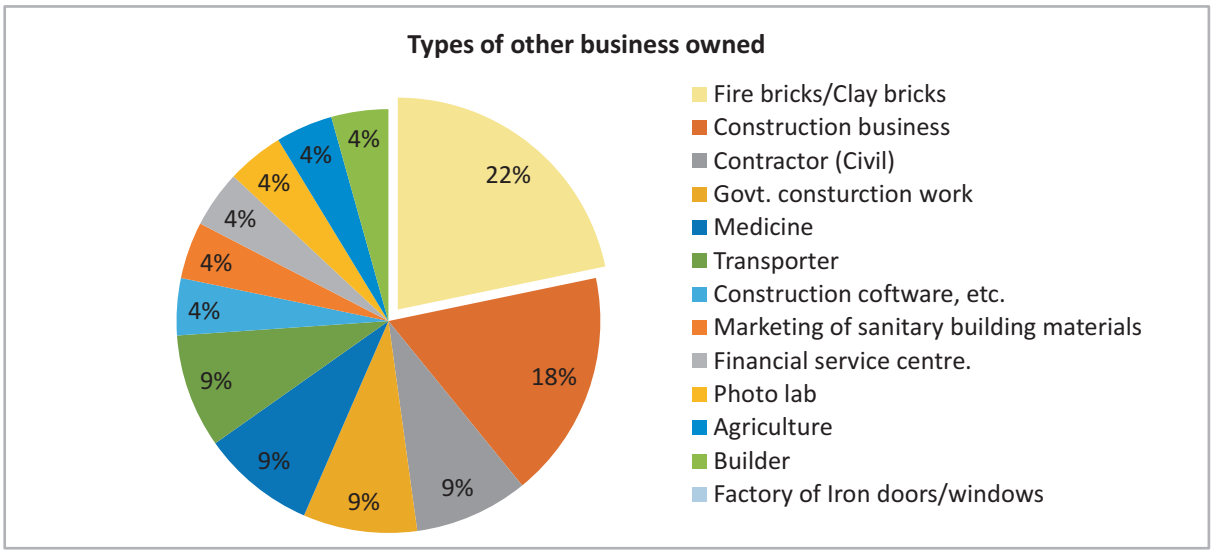

Figure 17: Type of other businesses owned

9. Product quality trends

Bricks from 47 units across Bihar were tested according to the Bureau of Indian Standards (BIS) testing procedure (BIS 12894). Bricks were tested for their compressive strength, water absorption, and determination of efflorescence.

9.1 Brick quality

BIS 12894 classify the fly ash bricks on the basis of their average wet compressive strength. The bricks are given a class designation from 3.5 (35 kg/cm^2) to 30 (300 kg/cm^2). The average compressive strength from selected districts of Bihar is shown in figure 18. Only 6 out of the 47 enterprises tested did not meet the quality set by IS standards.

The average compressive strength (kg/cm^2) for 48 units was calculated, and is shown in figure 20. The average compressive strength was found to be 9.14 N/mm^2 ranging from 80 to 120 kg/cm^2.

9.2 Quality by cluster

From figures 21, 22 and 23, we can see the average compressive strength per cluster. There is no definite trend according to the clusters. However, Patna has the highest average compressive strength with the minimum standard deviation.

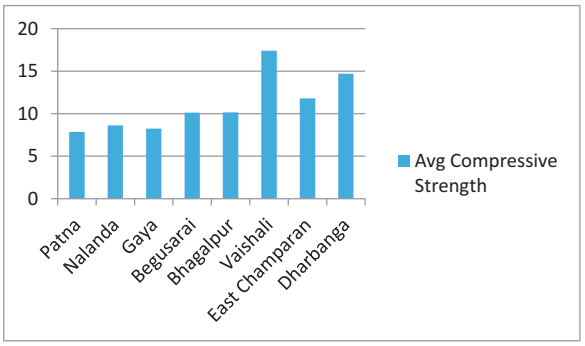

Figure 18: Average compressive strength in selected districts of Bihar

10. Market and financial trends

10.1 Production cost

The production cost of fly ash bricks depends on the cost of raw materials. The surveyed entrepreneurs have disclosed that the cost of sand is between Rs. 40 and 50 per kg, and that of cement is Rs. 7 per kg, both of which stay approximately the same state-wide. On the other hand, the cost of fly ash varies across the state.

According the notification of Ministry of Environment, Forests and Climate Change, 20 percent of fly ash should be provided free of cost to the entrepreneurs. However, transport and bagging charges are borne by

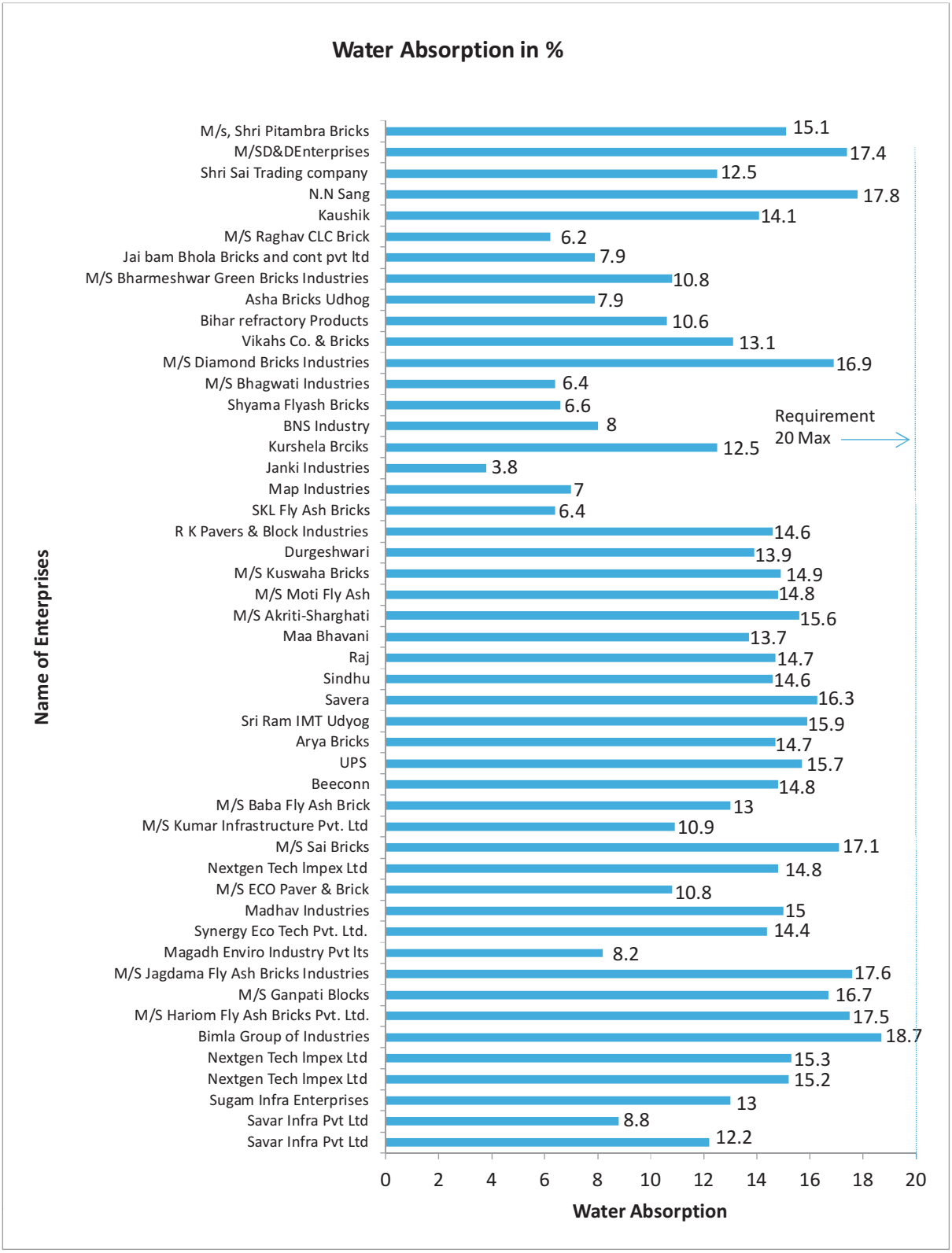

Figure 19: Graph on quality testing results – Water Absorption

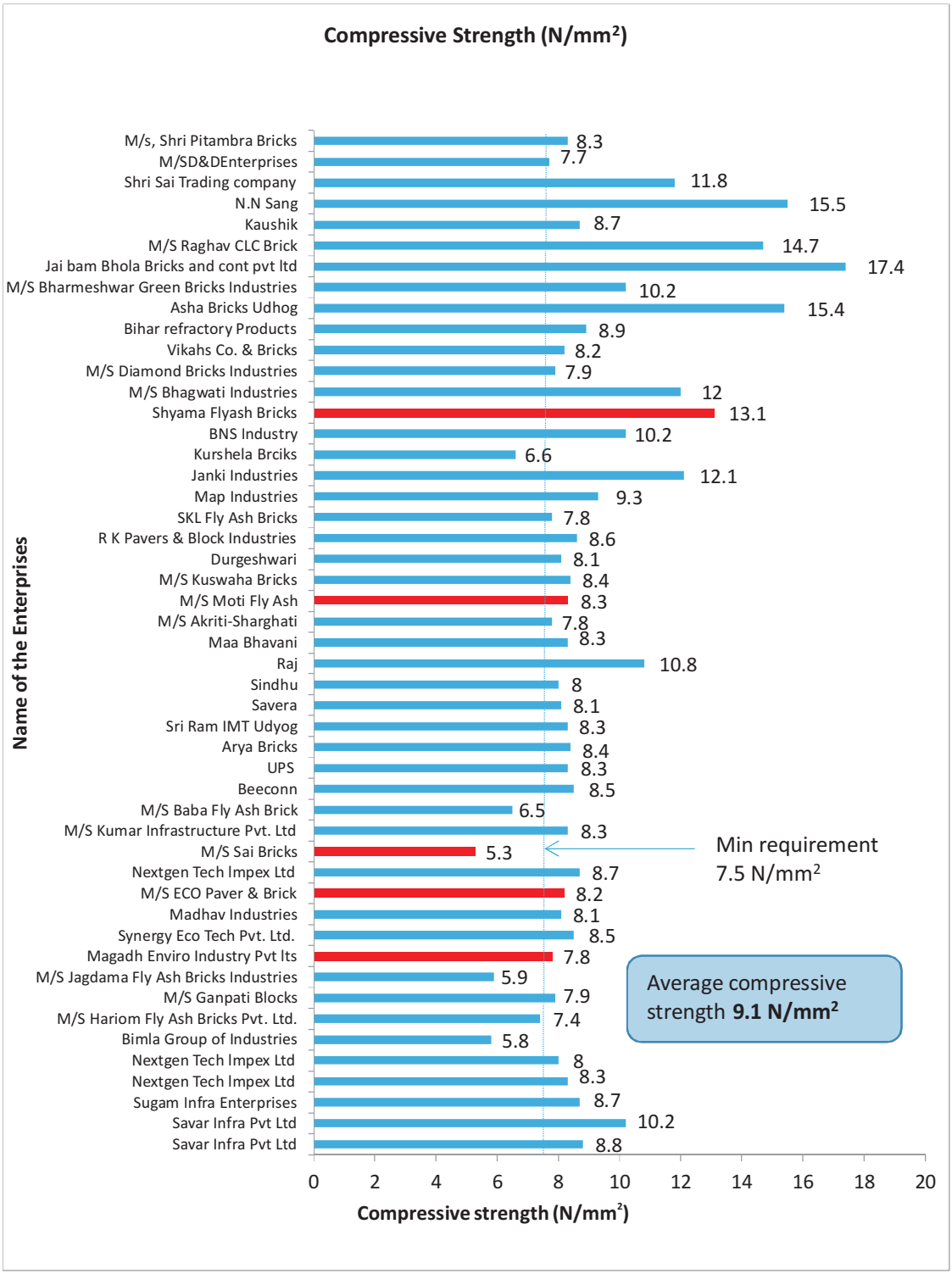

Figure 20: Graph on quality testing results – Compressive strength

Key findings from testing results

- 89.79% of the fly ash brick enterprises tested have conformed to the compressive strength requirements mentioned as per IS :12894: 2002
- 100 % of the fly ash brick enterprises have conformed to the requirements of water absorption mentioned as per IS :12894: 2002
- Average compressive strength of the bricks produced across the state of Bihar is found to 9.14 N/mm^2

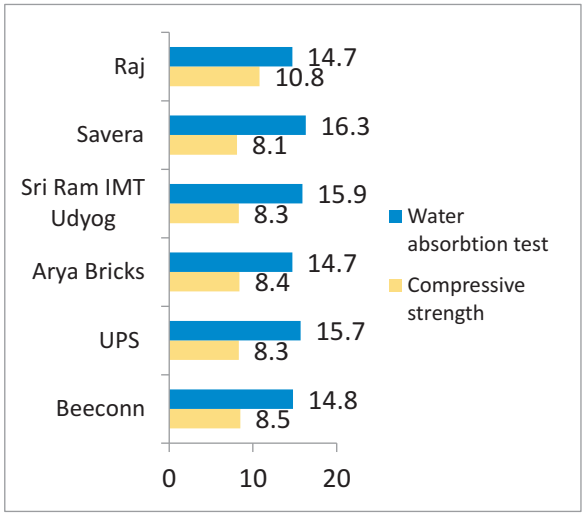

Figure 21: Nalanda quality cluster

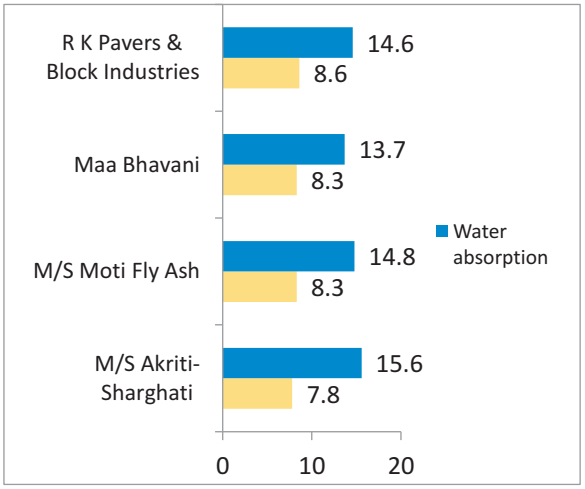

Figure 22: Gaya quality cluster

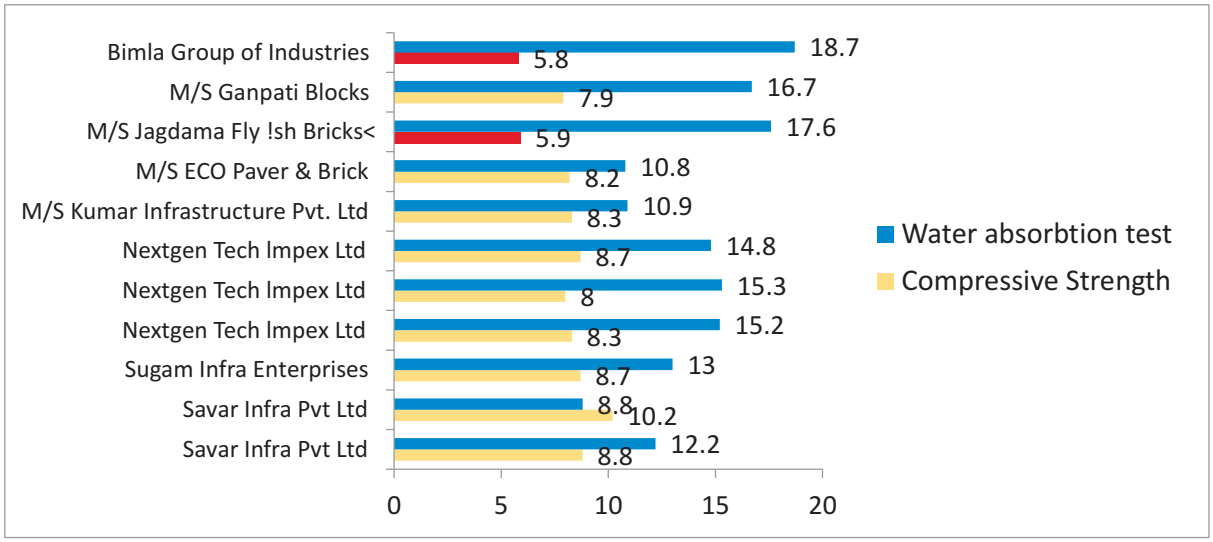

Figure 23: Patna Quality Cluster

the brickmaking unit. Hence, the total cost of fly ash depends on the distance of the brickmaking unit from the source of fly ash. For example, in Patna, which is the furthest from NTPC Kahalgaon, which is the source of fly ash for majority of the enterprises, the price of fly ash is around Rs. 1300 per tonne. Bhagalpur, which is nearest to the power plant, obtains fly ash for Rs. 200 per tonne.

10.2 Trends in selling price

The price of red bricks has been increasing over the years, due to rising coal costs; however, the price of red bricks has risen less than the increase in their production costs, thus reducing their profit margins. Because of this increase in production costs for clay bricks, fly ash bricks currently have a competitive advantage, making them more attractive for entrepreneurs to produce. Additionally, fly ash bricks do not suffer the fluctuations and increases in coal cost.

It is surprising that producers in Patna and clusters far away from Bhagalpur continue to produce bricks; this is indicative of the profitability of fly ash bricks. The producers in Patna are continuing to produce in anticipation of supply of fly ash in a full-fledged manner from NTPC Barh power plant, yet still manage to make a profit even when having to pay high production costs for the transport of fly ash.

10.3 Financial trends

Discussions with the brick entrepreneurs revealed that majority availed bank loans for establishing new units. Very few entrepreneurs set up new units through

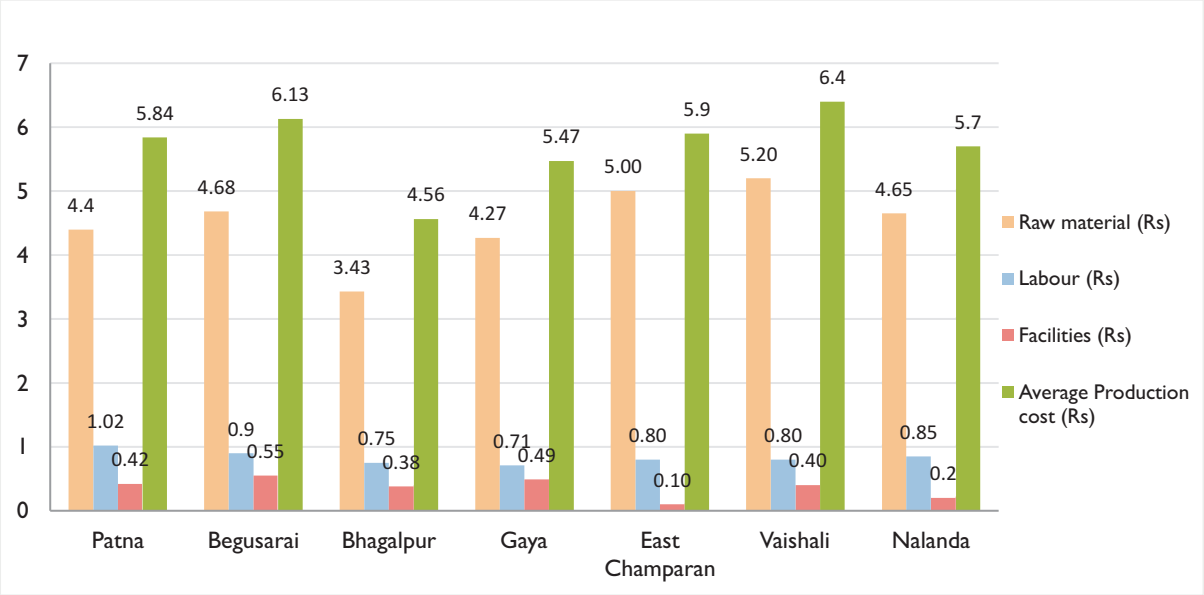

Figure 24: Average production costs of districts

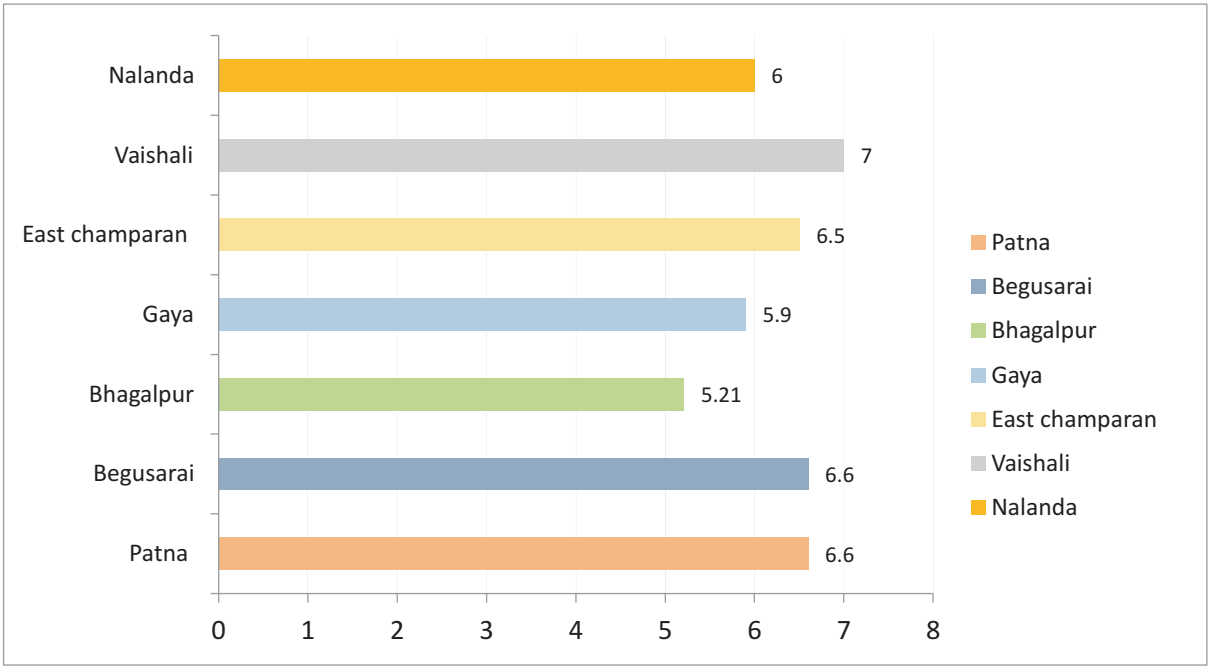

Figure 25 : Selling price of fly ash bricks (Rs)

independent finance. A mix of banks gave loans to entrepreneurs for setting up their units. Some of the major banks include State Bank of Baroda, State Bank of India, Punjab National Bank, Canara Bank and Bank of India. The reason that the SBI has a major share is because it is part of the State Level Banking Committee (SLBC), and is the nodal bank, and so is mandated to allocate some funds to the fly ash brick sector. However, many entrepreneurs complained about the delays in the approval of bank loans.

11. Impacts

11.1 Conservation of soil, carbon dioxide and coal

The impact of establishing new fly ash units on the environment can be measured in terms of conserved natural resources like coal and soil and reduction in carbon emissions. With the increase in number of fly ash units, the amount of coal saved increases

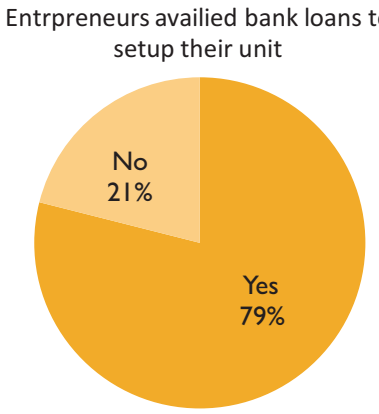

Figure 26: Financial aspects

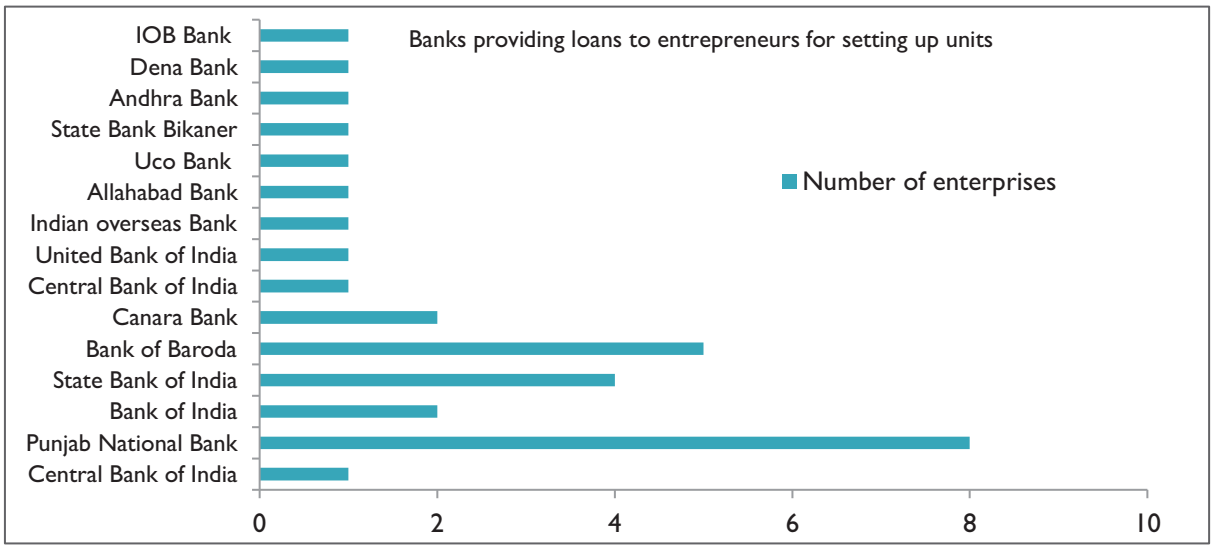

Figure 27: Banks providing loans to the entrepreneurs

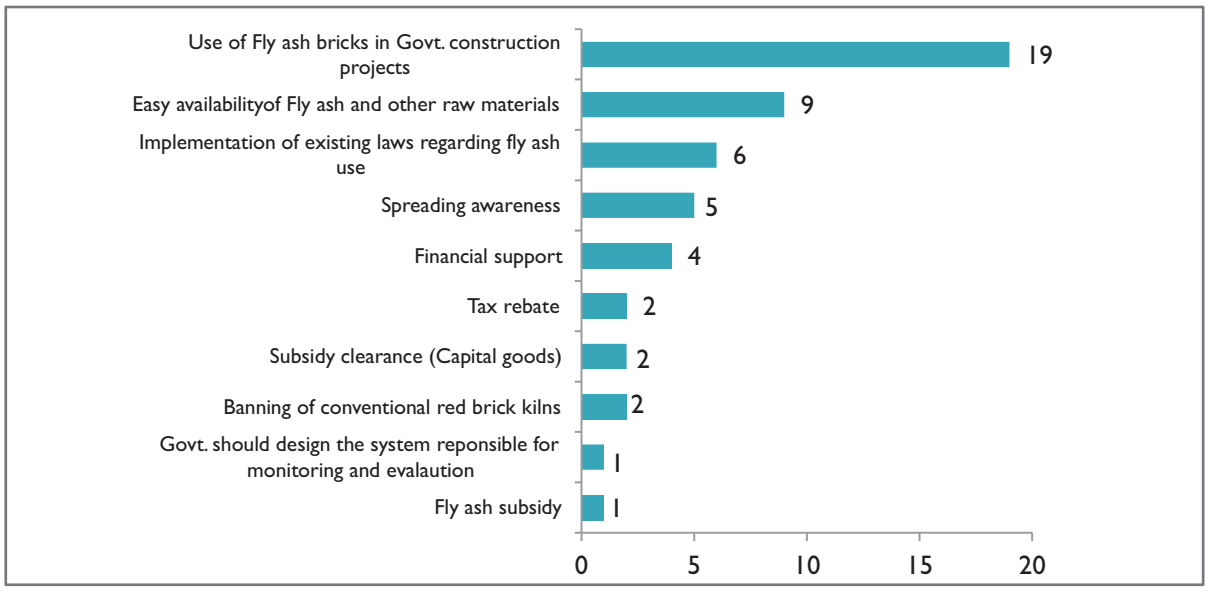

Figure 28: Type of support needed from the government

proportionally. Similarly, the tonnes of carbon emissions saved has also increased. Approximately 67,000 tonnes of coal and 210,427 tonnes of carbon emissions could be saved in 2016 if all of the fly ash bricks enterprises remained functional and continue to sell bricks throughout the year.

Fertile top soil is also conserved since it is not used for the production of bricks. Approximately 914,400 tonnes of soil can be saved in 2016, assuming that around 300 million fly ash bricks are produced.

11.2 Creation of jobs

In addition to environmental benefits, various social benefits are also associated with the commissioning of new fly ash units. The establishment of new units creates new employment opportunities. It has a potential to create 1935 jobs given all the 129 units were commissioned and remained operational during the study. A majority of workers are employed as labourers and operators, and work in save environments that do not witness high temperatures and dangerous conditions.

11.3 Future impacts

In terms of future projections, if we assume that all seven of Bihar's power plants – NTPC Barh, Navi Nagar Aurangabad, Jas Infrastructure, BTPS Barauni, MTPS Kanti, and NTPC Railway, in addition to the only power plant that supplies fly ash to brick makers, in NTPC Kahalgaon – are producing fly ash that can be used for brick making, then fly ash brick makers will be able to acquire almost 15.8 million tonnes of fly ash for free, assuming a 70 percent usage of the available free fly ash (which would be an increase on the 20 percent usage currently taking place). This means that there is the potential for 4,364 new fly ash units to be established once all power plants are operational and producing consumable fly ash. With a total of 4,389 fly ash units, it is possible to produce 10.53 billion bricks annually, saving more than 31.60 million tonnes of top soil, 7.27 million tonnes of CO_2, and 2.32 million tonnes of coal annually.

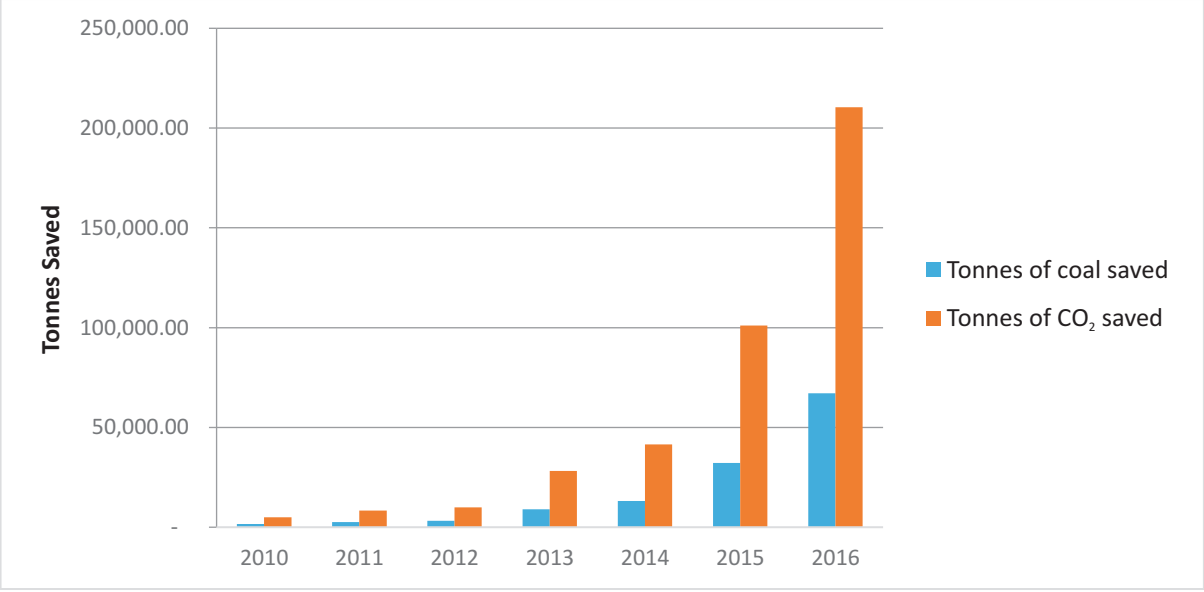

Figure 29: Annual savings in coal consumption and carbon emission

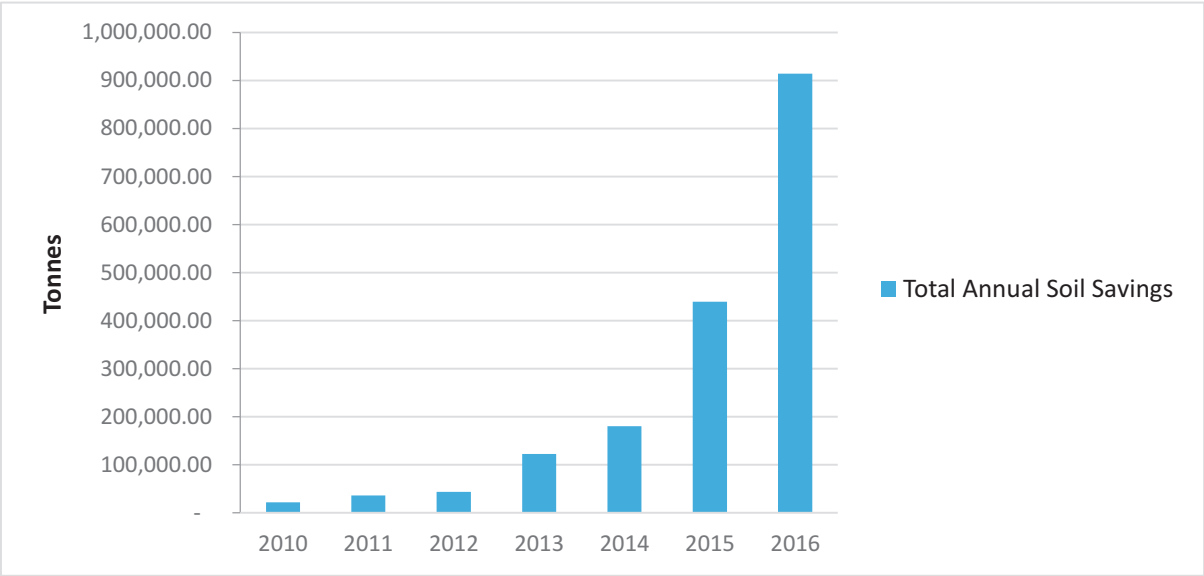

Figure 30: Soil saved annually

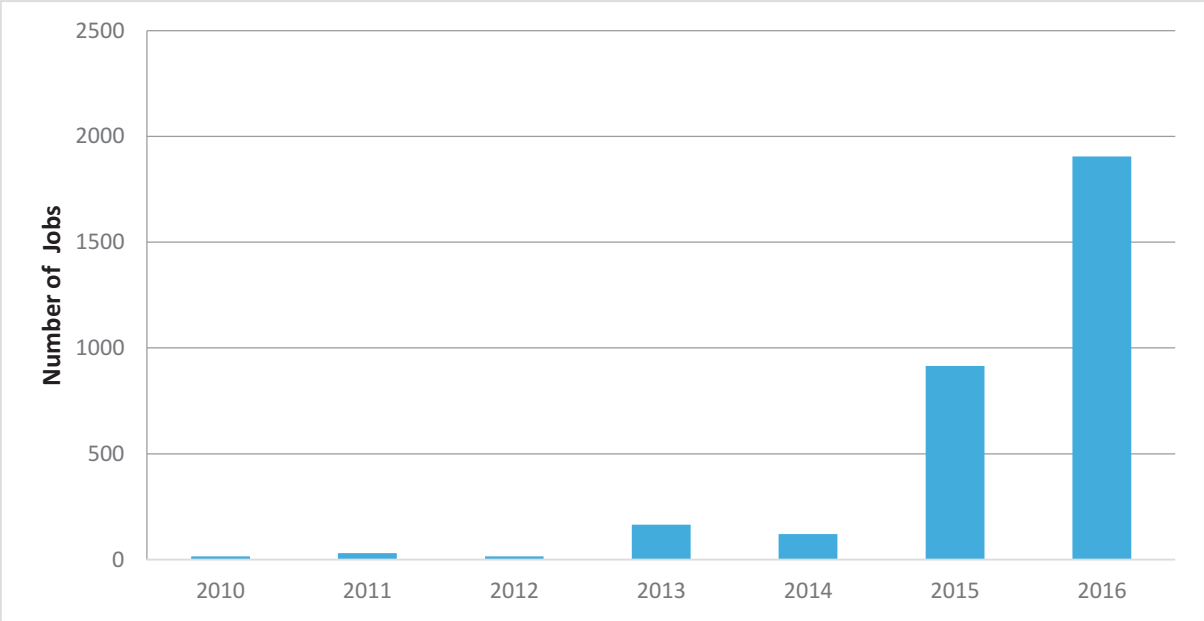

Figure 31: Jobs Created per annum

Table 3: Annual Impacts of fly ash brick units from 2016-2025 (PROJECTED)

Year	Brick produced	Soil saved (in tonnes)	Coal saved (in tonnes)	CO_2 avoided (in tonnes)	Market share
2016 (129 units)	**0.3 Billion**	**0.4 Million**	**0.06Million**	**0.21Million**	**1.69%**
2025 (Projected 4389 units)	**10.53 billion**	**31.60 million**	**2.32 million**	**7.27 million**	**58.2%**

Drivers and Barriers 3

1. Growth perspective of the Fly Ash brick industry of Bihar

The increasing demand for cement and bricks in the housing and infrastructure projects is exerting a huge pressure on the resources for raw materials, presenting us with a key challenge: Sustainable infrastructure development. The economic growth driven by conventional red brick industry has negative impacts on the environment and public health and necessitates the need for developing eco-friendly building materials which can yield huge benefits to the environment and the economy. The use of fly ash brick offers an opportunity for productive utilization of waste while preventing the emission intensity of the unit as well as providing jobs to the local community.

Development Alternatives (DA) has been working in several states of the country towards the development of fly-ash brick industry. These include Bihar, Odisha, Madhya Pradesh, Maharashtra, Orissa, Delhi, Jharkhand, Chhattisgarh and Haryana. According to DA's recent report, "The Fly Ash Brick Industry in Bihar"- with around 6,000 kilns, the state of Bihar produces approximately 18 billion bricks per year. Fixed Chimney Kilns (FCKs), which are resource and energy intensive, are the predominant technology in the state.

It is extremely important that initiatives are taken towards promoting cleaner brick production technologies and waste management. Support from the Bihar government has come in the form of its initiative towards becoming a low carbon economy by adopting cleaner construction technologies. In partnership with Development Alternatives, the Bihar State Pollution Control Board has organised several workshops to spread awareness and encourage the production and usage of fly ash bricks in the state.

Through Development Alternatives, TARA Machines has been involved in policy decisions at the government level in the states of Orissa and Bihar. This has helped the company to understand the shift taking place towards green technology leading to a growing market and increased engagement with the state. In the case of Orissa, certain policy decisions by the government have helped further in creating the demand for eco-friendly building materials. The

Orissa government's stringent coal norms and the ban on use of laterite stone have given an impetus to TARA Machines' technology and material. The company has also received support from an order mandating all government buildings within a 100 km radius of a power station to use fly ash bricks.

The establishment of fly ash brick making units since 2006 has achieved the following in Bihar:

- Produced 91.2 million bricks
- Saved approximately 274,000 tonnes of soil
- Saved 20,000 tonnes of coal
- Saved approximately 63,000 tonnes of CO_2

The current market share of fly ash bricks has decreased drastically due to the lack of demand. The scenario is likely to be reversed if a ban is imposed on the existing FCBTKs which cost the environment and public health. This could lead to acquiring 60 percent of today's clay brick market share. The increased production will have a positive impact on the environment and economy if rigorous implementation of pro-fly ash policies is in place.

Currently, fly ash brick units across Bihar have the capacity to produce approximately 300 million bricks per year. The policy notifications mandating all government buildings to use fly ash for construction purposes can play a key role towards the growth of the fly ash brick industry. Since the growth of the industry has been exponential till now, it can lead to a phenomenal growth of 5000 units in the next ten years.

2. Market drivers

Bihar needs over 7500 million bricks over the next five years just to meet the rural housing gap of 1.1 million dwellings per year. The increased use of environmental friendly products is also seen as a major driver behind setting up the enterprises by entrepreneurs across districts of Bihar. Another major driver comes in the form of support from government through initiatives such as banning existing brick kilns and conversion to cleaner brick production technologies. In addition to the potential savings of CO_2 emissions, the following were seen as the key drivers:

- Trends in coal price which is increasing the total production cost of bricks and reduced the profit margins for brick makers
- Resource and energy intensive brick making: 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. Additionally, 60,000 tonnes of wood per year are used rick making in the state, causing deforestation in the state
- Labour costs in the state of Bihar are increasing and shortages of certain types of labour are leading to pressure on the brick business
- High level of pollution: The brick sector not only emits high amount of carbon emissions but also other harmful gases such as Sulphur Dioxide (SO_2), Nitrous Oxide (N_2O), Carbon Monoxide (CO) and particulate matter that is harmful for health as well as surrounding agricultural land, orchards etc.

3. Barriers

Surveyed entrepreneurs raised several concerns regarding issues that hamper the operation of current units. The issues, such as a lack of market demand, delays in availing subsidies and loans, and the increased cost of fly ash through transportation, also hinder the further proliferation of fly ash brick technology.

3.1 Concerns of entrepreneurs

Lack of Demand

A negative and false mindset is prevalent among the consumers regarding the poor quality of fly ash bricks. The major reason for this mindset is the lack of awareness about these bricks. Concerns of quality reduce the market demand of fly ash bricks. Despite being included in the state Schedule of Rates (SoR) and tenders of the Building Construction Department, fly ash bricks are still not used widely in Government construction projects. Currently, the bricks are used primarily by private builders. Private builders and individual home owners constitute to more than 70 percent of the consumers of fly ash bricks. (See Figure 31).

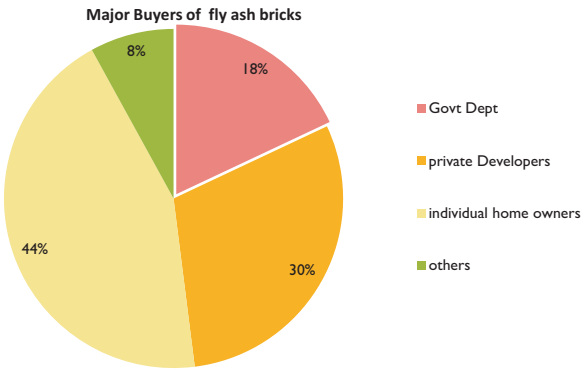

Figure 32: Major buyers of Fly Ash bricks

In fact, because of a lack of demand and production problems, fly ash makers are only operating at 53 percent of their rated production capabilities, which is an immense opportunity cost to the government and fly ash manufacturers. This is also extremely discouraging to producers and aspiring producers, who would only join the market were they sure, that they could make a maximal profit on their investments.

3.2 Concerns of buyers

Consumers had two key concerns on the timely supply of fly ash bricks and the lack of adequate quality. As can be discerned from previous section, several brick makers are producing substandard bricks, which need to be remedied through a quality control and assurance system. Additionally, some consumers are concerned that they cannot discern the quality of a fly ash brick visually as they do with red bricks.

The main concern for both entrepreneurs and consumers is that there exists a mindset problem, where fly ash bricks are thought of as poor quality due to their lack of penetration in the market, due to their relatively unheard-of technology, and due to the lack of a regulatory system regarding the product.

3.3 Financial barriers

Some relatively large brick-kiln owners may be in a position to self-finance kiln upgrades (e.g. retrofi tting of FCBTKs into Zigzag kilns), but that is not the case universally. Small- and medium-size operators would need access to financial services for kiln retrofits. Further, entrepreneurs interested in setting up large modern brick manufacturing facilities would also need access to finance. At present, there are several constraints that make conventional bank financing inaccessible to the brick-makers. Some of the main constraints are listed below.

- Most brick-kiln entrepreneurs operate on leased land and hence the land cannot be used for providing collateral security for availing loans.
- A large part of the brick trade takes place in cash, which means that tax compliance is poor and the profit and loss accounts and balance sheets of brick enterprises do not reflect the true picture of the trade and in establishing credit worthiness.
- Many brick-kiln entrepreneurs lack financial knowledge and the ability to prepare business plans and the documentation needed to apply for a loan.
- Commercial banks have limited experience lending to the brick sector and do not currently offer financial instruments tailored to this sector.

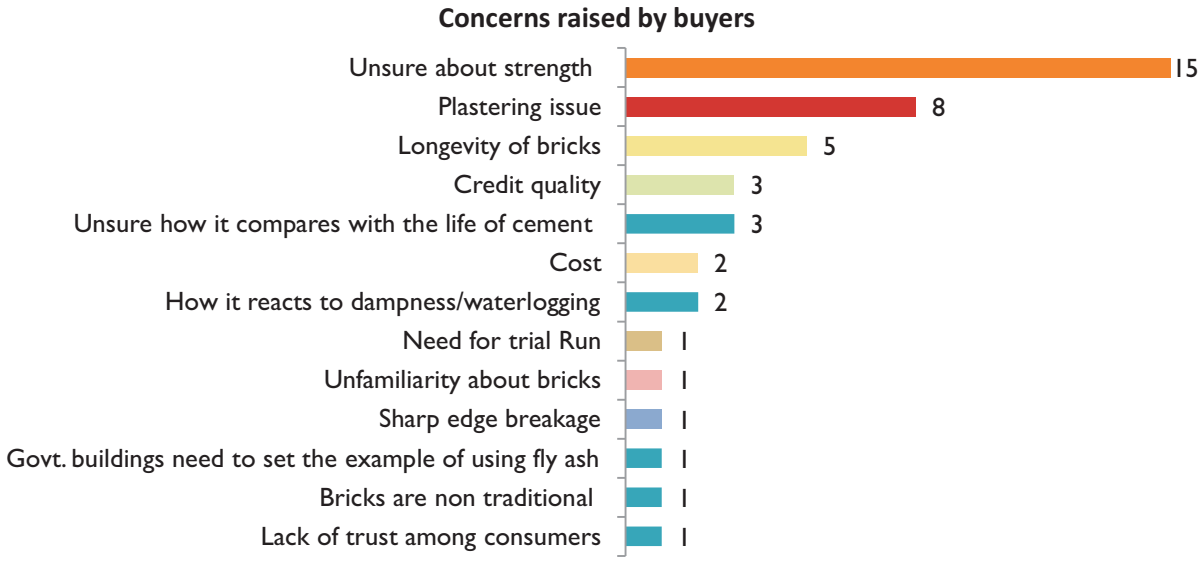

Figure 33: Concerns raised by buyers

Current Initiatives of the Government of Bihar

4

The government of Bihar has taken steps to accelerate the adoption of green brick production technologies in the state. Bihar will need over 7500 million bricks over the next five years just to meet the rural housing gap of 1.1 million dwellings per year. Potential savings of 2.8 million tonnes of CO_2 emissions are possible while creating livelihoods for 0.35 million people by introducing cleaner production systems.

In order to capitalise on this potential, the Bihar government has formed an inter-departmental task force (Box 1) on accelerating cleaner brick production. The Development Alternatives Group and Shakti Sustainable Energy Foundation are supporting this initiative. The Task Force is working towards introducing improvements in the sector with an aim to reduce pollution and the consumption of coal and fertile top soil. The four major areas that the Task Force will be looking at are as follows:

- Increasing awareness among entrepreneurs through workshops and seminars
- Facilitating policy support for large scale adoption by providing incentives to green technology enterprises
- Facilitating increased and easy finance support for small entrepreneurs through banks and other financial institutions for uptake of green technologies
- Accelerating service delivery through capacity building of technology providers

In conclusion, the three cornerstones to successful adoption of green technologies are favourable policy, easy access to finance and efficient service. If the triad is in place, the true potential of green technology to mitigate environmental damage can be met.

Box 1. Inter-departmental task force for cleaner brick production in Bihar

The Government of Bihar under an initiative towards low-carbon economy formed an inter-departmental task force involving various stakeholders for improving the brick sector in terms of pollution reduction, coal consumption, and use of top soil for brick production. A workshop was organized on 6 December 2012 by the Bihar State Pollution Control Board on cleaner brick production in Patna. The workshop was inaugurated by the Hon'ble Deputy Chief Minister of the state and was attended by more than 170 brick-kiln entrepreneurs, service providers, and various government officials. The formation of the task force was facilitated by Development Alternatives, an NGO, under an initiative of Shakti Sustainable Energy Foundation. The task force has proposed several actions to promote cleaner brick production.

Banning of existing brick kilns and conversion to cleaner brick production technologies

Patna is being listed by WHO as one of the top ten most polluted cities in the world. The Bihar State Pollution Control Board (BSPCB) has recently issued notifications not to grant consent-to-establish (CTE) new bricks kiln in five blocks of Patna Sadar, Danapur, Phulwarisharif, Maner and Fatuha of Patna district and to convert the existing bricks kilns into new cleaner technology by 31st of August 2016.

Recommendations 5

It is quite clear that the fly ash brick making industry needs incentives and support in order for it to deliver the benefits that it promises, but on a large scale. If Bihar is to grow its fly ash brick industry into one that shares a significant part of the market and provides significant coal and CO_2 savings, it will need to implement policies that favour a two pronged approach: ensuring the quality of the bricks produced

1. Improving supply side conditions

1.1. Creating awareness

Many entrepreneurs are unaware of fly ash bricks, and do not know about the profitability and superiority of fly ash bricks in comparison to clay bricks, thus preventing the expansion of the fly ash brick sector. There needs to be a major mindset change in order to counter the existing perceptions of fly ash bricks and their lack of quality, in the brick industry.

In order to counter the lack of awareness, Bihar must provide information to those unaware of the advantages of fly ash bricks; this is most likely to be done under the purview of the Department of Industries and Department of Environment and Forests. An information campaign targeting potential entrepreneurs and producers would increase market awareness of fly ash bricks. This campaign must promote bricks based on their financial and social merits: that fly ash bricks are cheaper to produce, equal or better in quality to clay bricks, do not require traditional brick kilns which produce harmful emissions, and pose less risk to workers through less dangerous machinery.

Several existing as well as potential entrepreneurs are also unaware of the subsidies and other incentives offered by the government. This campaign must also summarize the incentives that the state is offering for fly ash brick manufacturers. In summary, creating awareness takes the form of an information campaign through flyers, advertisements, and information sessions, which need to emphasize the merits of fly ash bricks and the incentives that the government is providing them.

The use of these bricks in government construction will also aid in popularising them among other

consumers. Department of Building Construction can play a crucial role in promoting fly ash bricks by utilising them in their own construction.

1.2. Incentives to producers and entrepreneurs

As has been mentioned before, almost 80 percent of the entrepreneurs surveyed required loans in order to set their firms up. Additionally, only 20 percent of surveyed entrepreneurs availed subsidies. The remaining did not, for various reasons, including a lack of awareness and delays in government response. This means that the existing system of providing subsidies needs to be streamlined, and that the government needs to improve its response time, which needs to be implemented by the Department of Industries and through Industrial Incentives Policies.

Banks were also averse to giving loans out to entrepreneurs, since the fly ash brick making sector is not viewed as financially sustainable. This means additional delays in financing and commencing production. The state needs to incentivise these banks through subsidies and legal action in order to ensure low-interest loans; it can also aim to change the image of the fly ash brick industry through the aforementioned awareness campaign.

While the state does offer a single window, many entrepreneurs are not aware that such a single window exists. This needs to be made clear through the awareness campaign. The subsidies need to be easy to understand by entrepreneurs from rural areas who may not be able to understand complicated paperwork because of a lack of education.

However, a point of intervention could be the involvement of service providers in acquiring the subsidies of Department of Industries. The subsidies could be claimed by the service providers in bulk thus reducing transaction cost and time and pass on benefits to entrepreneurs.

Additionally, efforts must be made in order to improve the means and methods by which producers source the fly ash. 25 percent of those surveyed explained that they had difficulties acquiring fly ash, because of transportation and cost issues.

2. Enhancing demand side conditions

2.1 Quality assurance and control

A major issue expressed by brick makers is the perception that their bricks are of poor quality. In addition to that perception, there are several brick makers who do not follow the right method for producing bricks, and there is no effective assurance that the bricks are of above-par quality. While there are standards for strengths, dimensions, and water absorption by the Bureau of Indian Standards (BIS), there is no system of quality control or of quality assurance. The lack of any kind of quality check and assurance mechanism leads to spurious products flooding the market, and the entire technology acquiring a bad name. The use of such substandard products also compromises the structural stability of buildings. This would impact the market demand of fly ash bricks. Therefore, it is necessary to address these concerns to ensure the further dissemination of this technology.

2.2 Rating system for quality production

A quality assurance and control system through a brick rating system, which will be upheld by the government and tested by independent laboratories, should be implemented. This will give a positive incentive to brick makers to maximize the quality of bricks, and will reward those who follow the correct procedures through incentivised sales. This would have to be done through the Department of Building Construction and Bihar State Pollution Control Board as well.

2.3 Preferential procurement

One of the major flaws in the campaign for the support for fly ash is that the government has not yet implemented preferential procurement. As has been shown in Figure 10, the private sector procures a majority of fly ash bricks on the market. The government does not purchase a large amount of fly ash bricks, which entrepreneurs have noted and are complaining of. Because of the noted benefits of fly ash bricks, the government should be buying and utilizing these bricks in the construction projects of the booming housing industry. This demand from the government will encourage entrepreneurs to set up in such a profitable industry, and will provide reassurance to the current entrepreneurs that their product will be bought. This preferential procurement should be implemented through the Building Construction Department.

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SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

About Shakti Sustainable Energy Foundation

Shakti Sustainable Energy Foundation was established in 2009 to support India's developmental objectives. We seek to facilitate India's transition to a sustainable energy future by promoting policies that encourage energy efficiency, renewable energy and the adoption of sustainable transport solutions.

Advancing smart energy policies will be key to meeting the defining challenge of the next generation—how to provide millions of Indians with reliable, affordable, secure access to energy in a sustainable manner.

We support the development of research and analysis to provide policy makers with concrete and practical policy recommendations for an energy secure future.

The energy choices that India makes in the coming years will be of profound importance. Meaningful policy action on India's energy challenges will strengthen national security, create jobs and keep our environment clean.

Development Alternatives

About Development Alternatives Group

Development Alternatives (DA) is a premier social enterprise with a global presence in the fields of green economic development, social equity and environmental management. It is credited with numerous technology and delivery system innovations that help create sustainable livelihoods in the developing world. DA focuses on empowering communities through strengthening people's institutions and facilitating their access to basic needs; enabling economic opportunities through skill development for green jobs and enterprise creation; and promoting low carbon pathways for development through natural resource management models and clean technology solutions.

Development Alternatives
B-32, Tara Crescent, Qutub Institutional Area
New Delhi 110016, India
Tel: +91-11-2654-4100, 2654-4200, Fax: +91-11-2685-1158
Email: mail@devalt.org, Website: www.devalt.org