SUSTAINABILITY OF BRICK PRODUCING MSMEs A STUDY OF THREE SOUTH INDIAN CLUSTERS

C. Narasimha and N. Nagesha

Brick-Industry
Energy-Efficiency
Pollution
MSMEs
India

C. NARASIMHA1* AND N. NAGESHA2
1Research scholar, Department of Studies in Industrial and Production Engineering, University BDT College of Engineering, Davangere - 577 004, Karnataka, INDIA, 2Assistant Professor, Department of Studies in Industrial and Production Engineering, University BDT College of Engineering, Davangere - 577 004, Karnataka, INDIA E-mail: narasimc@gmail.com

ABSTRACT

The Micro, Small and Medium Enterprises (MSMEs) are an integral component of the Indian economy. Most of these MSMEs tend to exist in geographical clusters and produce a variety of products like glass, plastic, rubber, leather, iron castings, textiles, bricks etc. Among them, brick making units are generally confined to rural and semi-urban areas. Though they make an important contribution to the economy in terms of employment and rural development, majority of them are traditionally operated using more energy at the cost of environmental degradation. This poses a threat to the sustainable development of such units. In this backdrop, the current paper probes various issues pertaining to energy and environment of such units, based on the primary data collected through a pilot study in the three south Indian clusters located in Karnataka, Andhra Pradesh and Tamil Nadu. The importance of energy input is studied using Cobb-Douglas production function. The energy consumption pattern is obtained and the resulting environmental pollution is estimated using the Intergovernmental Panel on Climate Change (IPCC) methodology. Further, various options for energy efficiency improvements and measures to reduce environmental pollution are also discussed. The study found energy as the most important contributor to the value of output amongst all the inputs. The study also indicates the scope and feasibility of pollution reduction through efficient use of energy, thereby leading to multiple benefits and hence sustainable growth of brick industries in the long-run.

*Corresponding author
INTRODUCTION

In India, brick producing MSMEs form a significant number of establishments contributing towards economic growth, employment generation and creation of base for developing skill of workers and entrepreneurs. A significant feature of them is that they have clustered naturally and spontaneously in different regions of the country and mostly confined to rural and semi-urban areas. Brick remains one of the most important building materials for construction activities in India. It is estimated that more than 115,000 brick making units operate; out of which about 15,000 are larger units and they use Continuous Kilns. The remaining kilns are of the intermittent type like Clamp, Scoved, and Scotch Kilns, etc. The prominent type of kilns used include (i) Rural Clamps or Brick Clamps (oldest method of firing bricks), (ii) Intermittent Draught Kiln (IDK), which is a batch type kiln, (iii) Bull’s Trench Kiln (BTK), a continuous type kiln and (iv) Vertical Shaft Brick Kiln (VSBK), which represents the latest technology and the most energy efficient. These brick kiln units are estimated to consume 24 million ton of coal per year along with a huge quantum of biomass producing about 140 billion bricks yearly with an annual turnover of more than Rs. 140 billion (Maithel and Uma, 2000). Brick making process involves preparing raw material, moulding (Manual/Machine), drying and storing (open/shed), and finally firing. It may be noted that the burning of brick is the most energy-consuming stage in its entire production cycle with energy cost accounting up to 30% of the total variable production cost and is carried out using brick-kilns.

Because of the increasing and widespread nature of these enterprises with their inefficient use of energy and other resources (Hamner, 2000), they contribute to local pollution expressed in terms of generation of Green House Gases (GHGs) and other pollutants. This includes Carbon Dioxide (CO$_2$), Methane (CH$_4$), Nitrous Oxide (N$_2$O), Carbon Monoxide (CO), Nitrogen Oxides (NO$_x$), and other adverse environmental impacts. Some of these effects may be reversible, but many are irreversible. Though energy consumption and environmental pollution may not be high at the individual unit level, at the cluster and national level the energy consumption and its environmental implications merit serious attention. Brick making units are also identified as one of the air and land polluting industries in the small-scale sector by the Central Pollution Control Board (CPCB).

There are a few studies regarding energy and environmental issues pertaining to brick making MSMEs. Nagesha (2010), Bala Subrahmanya (2006), Nagesha and Bala Subrahmanya (2006), and Subrahmanya and Balachandra (2002) have identified labor skill level, owner qualification and technology level as the important factors in explaining energy use and environmental pollution in the Indian context. However, Blackman and Geoffrey, (1998) found that small-scale brick makers in Ciudad Juarez, Mexico have responded significantly to informal community pressure for improved environmental performance. Further, Blackman (2000) has developed a list of feasible environmental management polices and examined how these polices have fared to control emissions from informal kilns in northern Mexico. Till recently, there was hardly any reference made either in government reports and documents or in research literature, to the environmental implications and impact of small scale brick industries with reference to India. However, many of the energy efficiency and environmental improvement initiatives in the small scale industry sector are not successful in India (Dasgupta, 1999). This can be mainly attributed to the presence of various factors such as technological obsolescence, lack of awareness among entrepreneurs about better alternatives, higher composition of unskilled labour force, etc. Nonetheless, how small industry clusters consume energy and generate pollution is interesting and useful to probe. In order to achieve sustainability it is important to identify, measure, value and integrate the energy and environmental impacts of activities in these energy intensive clusters.

In this background, the major objectives of this study are to establish the importance of energy amongst the inputs, to study the energy consumption pattern, to probe and ascertain the nature and magnitude of environmental pollution. Further, the measures to reduce pollution levels in small scale brick industry clusters are also discussed.

MATERIALS AND METHODS

Sampling and data collection
To meet the stated objectives, three environmentally polluting brick-making MSME clusters are chosen from the states of Karnataka, Andhra Pradesh and Tamil Nadu in South India. These clusters were identified after consultation with the officials of District Industry Centers (DICs), and field visits. The first cluster studied is at Malur, located about 50 kms from Bangalore in the State of Karnataka and has more than 200 brick producing units with majority of them employing IDK technology. The second cluster Tiruvallur is a town located on the Chennai-Tirupathi highway, approximately 44 kms from Chennai. It has around 150 brick units mostly operating with BTK technology. Krishna district of Andhra Pradesh is the third cluster studied and has almost all units with Rural Clamps. Local clay is used to produce bricks. Sand is sometimes added to get the right quality bricks and is normally produced only during the dry season, which lasts for 4-6 months. Digging, mixing, molding, etc., are all manual operations. The emergence of a large number of brick making units, irrespective of the kind of kilns used has resulted in consumption of large quantity of fuel. Overall, there appears to be significant problems with the energy supply. Brick makers complain that good quality coal is difficult to acquire while alternative energy sources, such as fuel wood show an increase in price. Despite this, the clusters are still dominated by energy-inefficient kilns without any emission controls. Thus, there is an urgent need for up-gradation of technology and training of labour, among others, for ensuring efficient use of fuel. This also substantially reduces the cost of produced bricks and results in minimized environmental pollution.

The data for this pilot study is gathered through a structured questionnaire and personal interviews with entrepreneurs from five units in each of the three clusters, selected randomly. The researcher administered interview gathered various information related to manufacturing process, kind of technology employed, type and quantity of raw material, annual quantity of fuel i.e. biomass and/or coal, annual brick production, etc.

Estimation of Pollution Levels

The pollution levels are determined based on the consumption of material/energy inputs used, nature of technology in use and the skill levels of the employees. It is intended to estimate pollution generated at the cluster level based on the data gathered from the sample units. For this purpose, standard pollution coefficients (emission factors) were worked out based on material and energy carriers and the combustion technology used. In addition, wherever applicable the various kinds of waste generated during the production process were also estimated. The methodology adopted is broadly based on the Intergovernmental Panel on Climate Change (IPCC, 1996) guidelines to estimate the greenhouse gas emission caused by brick making industries.

RESULTS AND DISCUSSION

Contribution of energy and other inputs in the output

Energy is one of the major inputs along with labour, raw material, and capital in the production of bricks from various materials. Thus, it would be appropriate to study how important is energy amongst all the inputs in explaining the variation in the value of output. For this purpose a multiple regression model is developed in the form:

\[ Y_i = b_0 + b_1E + b_2L + b_3K + b_4M \ldots (1) \]

Where: \( Y = \) Value of output of a SME in the cluster; \( K = \) Value of capital (Current value of Plant and Machinery); \( L = \) Labour cost; \( E = \) Energy cost; \( M = \) Raw material and other miscellaneous costs (excluding energy), \( b_0 = \) intercept, \( b_1, b_2, b_3, b_4 = \) Parameters that when estimated describe the quantitative relationship between the inputs and the output in multiple regression analysis. Further, the multiplicative Cobb-Douglas production function is used which reduces to a log-linear relationship to represent the relationship of an output to its inputs (Moroney, 1967).

\[ \log Y_i = \log b_0 + b_1 \log E + b_2 \log L + b_3 \log K + b_4 \log M \ldots (2) \]

Where: \( \log = \) logarithmic transformation of variable. If all inputs and the output are expressed in monetary terms, the coefficients of independent variables may be used for interpreting the importance of the independent
variables in explaining the variation in the dependent variable. Table 1 gives the result of multiple regression analysis. Stepwise regression method with Statistical Package for Social Sciences (SPSS) is employed for this purpose. From the Table 1, it can be noted that the regression model is appropriate as it has significant ‘F’ value. The independent variables included appear to explain a large amount of variation in the value of output as reflected in the high value of adjusted $R^2$. The energy and raw material (excluding energy) consumed turned out to be significant in explaining the variation in value of output. Even though the labour costs account for a large variation in output it has not turned out significant in this analysis. Further, capital represented by current values of plant and machinery is found statistically insignificant in explaining the variation of the value of output. Since energy is the most important input apart from materials in the studied MSME clusters, it is meaningful to probe its consumption pattern.

**Energy consumption pattern**

The brick cluster of Malur predominantly uses biomass (Eucalyptus leaves), whereas Tiruvallur and Krishna district clusters use coal for the production of bricks as shown in Table 2. The other energy carriers like diesel and electricity account for a trivial share in total energy use. Electricity is mainly used for lighting purposes and in running water pumping motors. Diesel is consumed only by enterprises which have captive diesel engines for use, when power from the electricity board is unavailable. Based on the primary data through pilot study the total energy use in the sampled units is computed and is then projected to the entire cluster.

The energy consumption pattern in the brick industry clusters helps in understanding how energy consumption varies within a cluster, and among the clusters. It reveals how different energy carriers are used apart from indicating the possible energy efficiency potential that exists in these MSME clusters. The average annual energy consumption varied from one cluster to the other due to variations in technologies of production, type of energy carrier, and their production volumes. Further, based on the interactions with the entrepreneurs in these clusters, it is strongly felt that the factors like age of plant and machinery, quality and type of fuel used, work practices, technology used, production capacity utilization, entrepreneurial qualification and labour skill level, etc., are also crucial in determining the energy efficiency level in a brick making MSME.

**Assessment of environmental pollution**

The general environment in and around the MSMEs of the three brick-making clusters did not appear very clean. Further, it appears that the owners have neither bothered to take serious measures to keep the premises clean nor to control the local pollution. Ash and waste bricks are dumped in the unit premises in a haphazard manner. Coal ash is the main solid waste generated in brick kilns whereas over-burnt and broken bricks also constitute a substantial amount of waste and are piled up near the stockyard and are discharged to the lakes and pools around the industries or sold to villagers for some nominal prices. On the whole, air pollution due to the consumption of Eucalyptus leaves/firewood and coal, is the major environmental concern, identified in the brick-making clusters.

Table 3, gives the summary of annual environmental pollution levels in the three clusters based on the data collected in this pilot-study. Looking at the estimated annual air pollution figures, one can definitely say that the MSMEs collectively cause substantial air pollution at the cluster level, if not at the individual unit level. Apart from this estimated air pollution, the brick cluster is also a source of considerable land pollution due to scrapping of the wastes generated in nearby land areas as indicated earlier.

The environmental impacts caused by brick industries are diverse which include deforestation, land degradation accompanied by soil erosion, localized pollution, and loss of floral and faunal diversity. Traditional brick production requires a great deal of fuel during firing. High fuel use increases air pollution. Smoke and gases are emitted from burning of biomass and/or coal used in firing and burning of the soil components resulting in respiratory illnesses for the labour force. It has also an adverse effect on the vegetables produced along river banks. It results in deforestation and includes loss of nature’s biological diversity and its aesthetic
values leaving less wood for future use. Brick and tile production can alter the landscape in ways that are harmful to the environment and may hamper future business plans. It can create clay pits or “borrow” areas, which, if improperly managed, can become safety hazards. They may also accumulate rainwater and become habitat for mosquitoes. These effects, with associated soil erosion, may make land unusable for farming.

Measures to enhance energy-efficiency and reduce environmental pollution

Based on the results of the field study and subsequent analysis of the data gathered, following recommendations are made that are likely to enhance the energy-efficiency and hence reduce the environmental pollution levels:

Adoption of energy-efficient technology for producing bricks: This could be in terms of increasing efficiency and reducing emissions by using kiln structures that require less fuel, better methods of brick moulding, proper drying of green bricks, better firing practices, use of waste heat for preheating of bricks, providing training to the labourers, using alternative fuel types such as rice husks or sugar bagasse, installing filters in chimneys, etc.

Maintain kiln structure and repair cracks or leaks to reduce thermal losses.

Prepare a safety and health plan to minimize adverse respiratory effects and physical stress on kiln workers.

Consider planting fast-growing tree species, to maintain a source of fuel. Tree planting also helps to prevent soil erosion, reduce siltation of water bodies and maintain soil fertility.

Set topsoil aside before removing clay and replace it after production is over. If topsoil has been lost or

### Table 1: Production Function (Regression) Analysis

<table>
<thead>
<tr>
<th>Ln [Energy]</th>
<th>0.546(2.183)[0.031]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln [Labour]</td>
<td>-</td>
</tr>
<tr>
<td>Ln [Material]</td>
<td>0.374(1.064)[0.052]</td>
</tr>
<tr>
<td>Ln [Capital]</td>
<td>-</td>
</tr>
<tr>
<td>Ln {A} - Const</td>
<td>1.295(3.603)[0.004]</td>
</tr>
</tbody>
</table>

Adjusted R²: 0.954

F: 97.36 [0.000]

N: 15

### Table 2: Energy Consumption Pattern in the Brick Clusters

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Energy Carrier</th>
<th>Carrier Total Annual Consumption in MSME clusters (TJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Malur</td>
</tr>
<tr>
<td>1</td>
<td>Firewood (Bio-mass)</td>
<td>Eucalyptus leaves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.646</td>
</tr>
<tr>
<td>2</td>
<td>Coal</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Electricity</td>
<td>0.0000929</td>
</tr>
<tr>
<td>4</td>
<td>Diesel</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total Energy Consumption</td>
<td>8.6460929</td>
</tr>
<tr>
<td></td>
<td>Total Brick Production(Annually for sample of five units in each cluster )</td>
<td>902,000</td>
</tr>
</tbody>
</table>

### Table 3: Annual environmental pollution in the MSME clusters

<table>
<thead>
<tr>
<th>Cluster (five units in each cluster)</th>
<th>CO₂ (kg)</th>
<th>CH₄ (kg)</th>
<th>CO (kg)</th>
<th>N₂O(kg)</th>
<th>NOₓ (kg)</th>
<th>Wastage – Bricks (in the five units)</th>
<th>Ash (Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malur</td>
<td>685.90</td>
<td>1.571</td>
<td>91.67</td>
<td>0.002</td>
<td>0.129</td>
<td>74,000</td>
<td>8.86</td>
</tr>
<tr>
<td>Tiruvallur</td>
<td>4823.83</td>
<td>2.924</td>
<td>61.57</td>
<td>0.051</td>
<td>6.985</td>
<td>2585,000</td>
<td>310.17</td>
</tr>
<tr>
<td>Krishna</td>
<td>4872.70</td>
<td>3.789</td>
<td>117.7</td>
<td>0.050</td>
<td>6.706</td>
<td>1026,000</td>
<td>143.64</td>
</tr>
</tbody>
</table>
dispersed, fill the borrow pit with soil to avoid creating pools of water that attract mosquitoes leading to land degradation.

CONCLUSION

The current study probed the importance of energy input amongst other inputs, energy consumption pattern, and environmental pollution in the three South Indian brick producing MSME clusters. The Cobb-Douglas production function found that energy is the most important contributor to the value of output amongst all inputs. The study revealed that the firms in these clusters generally use obsolete technology, with associated high levels of pollution from the processes by consuming more inputs. It is observed that efforts are needed to reduce fuel consumption and the pollution level of the existing kilns as it results in the twin benefits of cost reduction and minimized environmental damage. Upgrading kiln technology and possibly adding emissions control devices, providing proper training to labour etc., can result in improved energy-efficiency coupled with reduced environmental pollution and hence lead to the survival and growth of these brick industry clusters in the years to come.

REFERENCES


