Chapter 4.1

Brick and Tile Production: Cleaner Production Fact Sheet and Resource Guide

Purpose

This fact sheet offers basic information on the important adverse environmental impacts of brick and tile production, as well as associated health and safety impacts. It also discusses opportunities for mitigating those impacts, with an emphasis upon "cleaner production" strategies that may also provide financial benefits to micro- and small enterprises (MSEs). In addition, each fact sheet offers a substantial, annotated list of resources for those organizations seeking more information.[2]

This fact sheet has been prepared for (1) **business development services (BDS) providers**, which offer services such as management training or marketing support to MSEs, and (2) **intermediate credit institutions (ICIs)** and **direct lenders** that provide financial credit to MSEs. It is intended to be used in concert with Section 3.4 of the *Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Humanitarian and Development Activities,* USAID Africa Bureau's principal source of sector-specific environmental guidance.

Why Focus on Cleaner Production for Mitigation?

Cleaner production (CP) is a preventive business strategy designed to conserve resources, mitigate risks to humans and the environment, and promote greater overall efficiency through improved production techniques and technologies. Cleaner production methods may include:

- substituting different materials
- modifying processes
- upgrading equipment
- redesigning products

[2] At the time of writing , USAID cleaner production fact sheets are available for the following subsectors that are likely to have substantial adverse impacts on the environment and/or worker health: brick and tile production; leather processing; small-scale mining; food processing; metalworking; wood processing and furniture making, and wet textile operations.

In addition to environmental, health and safety benefits, many cleaner production techniques provide opportunities to substantially reduce operating costs and improve product quality. MSEs can profit from cleaner production through more efficient use of inputs and machinery, higher quality goods that command higher prices, and reduced waste disposal costs. Improved safety measures can also help MSEs avoid costly accidents and worker absences.

Experience has demonstrated that, with assistance, MSEs can frequently identify cleaner production opportunities that produce a positive financial return, sometimes with little or no investment. Many enterprises that change to cleaner production methods may realize substantial financial and environmental benefits, indicating that cleaner production should be the first option considered in addressing MSEs' environmental problems.

Yet, although this approach can offer tremendous advantages, readers should also recognize that cleaner production options showing clear financial benefit will only be available to varying degrees among different enterprises and often may not completely mitigate environmental problems. In some cases, even when pursuing cleaner production techniques, some businesses may need to use solutions that offer no measurable financial return—if such solutions are required by USAID's Regulation 216 or local regulations or desired for other reasons, such as community goodwill.

Important Environmental Issues Addressed by This Fact Sheet

- Inefficient use of fuel
- Resource extraction and depletion
- Inefficient use of non-fuel inputs
- Dust

Adverse Environmental Impacts and Mitigation Opportunities

Several key environmental impacts associated with brick and tile production are listed in the box at right and discussed below. For each impact, the fact sheet provides a list of questions to aid in the assessment of individual MSEs. These questions are followed by a number of mitigation strategies that can be considered, with an emphasis on cleaner production strategies where possible. The strategies presented typically represent a range of available options, from profitable activities that require no investment to other activities that may increase MSE costs.

Inefficient use of fuel

Traditional brick and tile production requires a great deal of fuel during firing. Inefficient production technologies and techniques and excessive fuel consumption are typical. High fuel use increases air pollution, exacerbating respiratory illnesses. It also increases deforestation and associated environmental impacts, leaving less wood for future use. Reducing consumption reduces fuel costs, conserves resources and lowers pollution levels.

Key questions to consider:

- What type of fuel is used in production? Where does it come from?
- What other types of fuel are available?

- Are there leaks or openings in the kiln structure?
- How close are settlements to the (proposed) kiln site?
- How much exposure to smoke and ash do workers have?
- How much bending and lifting do workers do?

Selected Mitigation Strategies:

- Use alternative fuel types. Organic wastes such as rice husks or sugar bagasse can supplement scarce fuel sources, such as wood, without sacrificing efficiency.
- Raise kiln temperature using improved firing techniques. Adding combustible material around the bricks or between clamps can increase temperatures and lower traditional fuel needs.
- Maintain kiln structure and repair cracks or leaks. Even small leaks can substantially increase fuel costs over time. Monitor structure and machinery to identify potential leaks.
- If traditional brick-making technology is used (brick clamps), ensure adequate insulation of the clamp and orient it at a 90° angle with prevailing wind direction to reduce underfiring or overfiring of bricks. See http://www.gtz.de/basin/gate/brickclamps.htm for a more extensive review of best practices.
- Increase efficiency and reduce emissions by using kiln structures that require less fuel. Ventilated-shaft brick kilns (VSBKs) or bull trench kilns (BTKs) are effective in reducing smoke and lowering the amount of fuel required for firing.
- Install filters in chimneys. One small-scale brick producer used broken brick pieces to absorb carbon dioxide (CO^2) and reduced emissions substantially.[3]
- Prepare a safety and health plan to minimize adverse respiratory effects and physical stress on kiln workers.

Resource extraction and depletion

Brick and tile production can alter the landscape in ways that are harmful to the environment and may hamper future business plans. Production can deplete local sources of fuelwood, eventually raising the cost of labor for acquiring fuel. It can also 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 render land unusable for farming. For all these reasons, landowners or communities may resist further expansion.

[3] For more information, see "Remediation of airborne polyaromatic hydrocarbons (PAHs)" in the reference section of this document.

Key questions to consider:

- How is the landscape expected to change (from tree-cutting, borrow pits, etc.) over the course of production?
- Are there leaks or openings in the kiln structure?

Selected mitigation strategies:

- Consider planting fast-growing tree species that can be coppiced easily, such as *Leucaena* or *Albizia*, to maintain a source of fuel. Tree planting also helps to prevent soil erosion, reduce siltation of water bodies and maintain soil fertility. If trees are planted, ensure clear ownership to encourage better long-term management.
- Return land to a usable state. Set topsoil aside before removing clay and replace it after production ends. If topsoil has been lost or dispersed, fill the borrow pit with soil to avoid creating pools of water that attract mosquitoes.

Inefficient use of non-fuel inputs

Inefficient production techniques reduce productivity and create excessive waste. Improper brick and tile formation and low-quality inputs result in a high number of bricks or tiles that crack or break during firing and must be discarded. This decreases output and increases waste disposal costs. Brick or tile wastes require significant amounts of space, leaving less land available for other uses. Better use of technology and training will increase productivity and efficiency while reducing costs and waste.

Key questions to consider:

- What kind of machinery is used in the production process?
- What kinds of raw materials are used in production and how are they identified?
- What quality control processes are used to evaluate raw materials?
- What waste will be left after production is finished?

Selected mitigation strategies:

- If little or no machinery is used, consider low-cost technology improvements. Decrease losses during firing by improving brick preparation: use an extruder to process clay, or form bricks with manual presses.
- Improve input quality. Bricks that crack during firing may have too much organic material in them or too much topsoil mixed in with clay. Train workers in identification of clay, and monitor quality regularly.
- Consolidate or remove brick and tile waste once production ends. This waste may be scattered over a large area and impede future farming

activities. Investigate possible uses of broken or burnt brick for construction and other processes.

Dust

Dust, a byproduct of brick and tile production, may cause serious health problems. Dust is most prevalent and most dangerous when clay is extracted and when finished bricks are transported following the firing process. Inhaling rock dust can lead to silicosis, a disease that affects lungs and breathing. Silicosis lowers the productivity of workers and can have long-term and even fatal effects on the health of workers, owners and people who live close by (including the families of workers and owners).

Key questions to consider:

- When is dust most prevalent in the production process?
- What safety measures are available to workers?

Selected mitigation strategies:

- Provide workers with face masks and instruct them to use masks in high-dust operations.
- Dampen bricks and tiles to keep dust down. In particular, if bricks or tiles are made and then broken for use in construction, make sure to dampen them first. However, try not to use excessive water.

Chemical pollution

Adding pigment to bricks or glazing roofing tiles produces chemical wastes that could harm workers, pollute the air and contaminate water supplies. Glazing and enameling require materials that contain acids or metals, and improper handling or excessive contact can lead to metal poisoning, skin irritations or lung disease. An unhealthy workforce can lower productivity, miss work too often and contribute to costly mistakes. Poor housekeeping practices can waste these materials, raising input costs.

Key questions to consider:

- What types of glaze or enamels are used in production?
- What safety and housekeeping measures do workers practice?
- Are chemical wastes disposed of away from water sources?

Selected mitigation strategies:

- If possible, use water-based acrylic glazes to minimize adverse environmental impacts.

- Improve storage practices. Close containers containing glazing or enameling material to prevent product loss through evaporation, spoilage or spills, and to minimize workers' exposure to fumes.
- Require workers to wear masks when they are using glazing or enameling chemicals.
- Require workers to wash hands after working with glazes. Many glazes have traces of metal that can cause metal poisoning when ingested. Provide gloves made of rubber, vinyl or other impermeable materials for workers handling glazes and glazed material.
- Ventilate kilns after firing. Dangerous gases and fumes escape during the firing process and can sicken workers removing bricks or tile.
- Prevent water contamination. Apply glazes away from water sources and dispose of chemical wastes properly. Do not clean spilled glazes with water. Sprinkle them with absorbent material such as straw, clay or dirt, and sweep up the spill into a separate container. Sweepings should be disposed of in a way that prevents leaching of heavy metals from the glazes into water supply (such as clay- or concrete-lined pits).

References and Other Resources

- *Status and Development Issues of the Brick Industry in Asia* (1993). Field Document No. 35, UN Food and Agriculture Organization (FAO).

  http://www.rwedp.org/acrobat/fd35.pdf. A comprehensive description of brick production and alternative technologies that improve production. Specific reference to kiln types and different methods of input extraction.

- "Energy Saving in Brick Industry: Brick-by-Brick Approach to Sustainable Development." (1999) Terivision No. 18. Tata Energy Research Institute.

  http://www.teri.res.in/teriin/news/terivsn/issue18/main.htm. A general discussion of improving energy efficiency in the brick industry. This is not a very technical document but includes useful starting strategies to dealing with energy issues.

- *Energy Efficiency Improvement in the Brick, Tile and Lime Industries on Java* (1987). World Bank Energy Sector Management Assistance Program. UNDP, World Bank.

  http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3960928074130 This report discusses improvements in the brick, tile and lime industry in Indonesia. Particular attention is paid to methods of improving clay preparation and reducing tile breakage in the kiln.

- *Uganda: Energy Efficiency Improvement in the Brick and Tile* Industry (1989). World Bank Energy Sector Management Assistance Program. UNDP, World Bank.

  http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3960928084948. This report analyzes technical and economically feasible means for improving energy efficiency in brick and tile production in Uganda. Specific discussion of fuelwood conservation.

- Majzoub, Mohammed (1999). Utilisation of Bagasse in Brick Making: R & D in Sudan. *basin/GATE-GTZ.*

  http://www.gtz.de/basin/gate/tb10/sudan1.pdf. The technical brief describes the result of research undertaken by the basin program in Sudan on the use of bagasse, a by-product of the sugar industry, in brickmaking. It compares types and quantities of wood-fired and bagasse-fired bricks and the costs of cow dung and loose bagasse with total production costs.

- Aluoch, Giblet O (1997). *The Effect of Brick Making on Social Forestry in East Gem, South Nyakach and North Maragoli Locations of Lake Victoria Basin—Kenya.* Care International in Kenya, Agroforestry Extension Project, Kisumu, Kenya.

  http://iufro.boku.ac.at/iufro/iufronet/d6/wu60603/proc1997/aluoch.htm. A case study of three different locations around the Lake Victoria catchments area, estimates the extent of soil damage and other negative effects associated with brick making. Identifies the best intervention points, when and how to intervene to improve efficiency of brick making, how to reclaim degraded sites and conserve fuel wood.

- *Clay Preparation Methods*. Wall Technical Briefs. German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/tb13/clayfiring.zip;
  http://www.gtz.de/basin/gate/tb11/clayprep.zip
  http://www.gtz.de/basin/gate/tb12/claydrying.zip. A series of technical briefs dealing with drying of clay for brick- and tile making, preparation of clay, molding and firing of clay bricks and tiles. The brief describes basic drying processes, different drying methods, surface treatment, drying tests, choice of drying methods, economics and flexibility. A table explains drying faults, their causes and remedies.

- *Glazing for Concrete Roof Tiles* (2000). RAS Technical Bulletin No. 10. SKAT.

  http://www.skat-foundation.org/resources/downloads/pdf/as/Technical%20Bulletin_10.pdf. A short fact sheet about water-based glazes for roofing tiles. Water-based glazes are safer and less toxic than acrylic or other chemical-based glazes.

- *The Clay Brick Industry: Improvement of Resource Efficiency and Environmental Performance* (2000). Cleanerproduction.com, Hamner and Associates LLC.

  http://www.cleanerproduction.com/industries/clay.html. A good explanation of cleaner production solutions to brickmaking. Includes a checklist of cleaner production strategies as well as links to other relevant Web sites.

- Blackman, Allen and Geoffrey J Bannister (1998). *Pollution Control in the Informal Sector: The Ciudad Juárez Brickmakers' Project*. Discussion Paper 98-15, Resources for the Future.

  http://www.rff.org/CFDOCS/disc_papers/PDF_files/9815.pdf. This case study discusses the development of technology for improving polluting emissions among small-scale brick makers in Mexico.

Other Resources

- “The Environmental Colours of Microfinance Theory” and “Practice Enabling the link between Microcredit and Environment” in *Promoting Environmentally Based Micro-*Enterprises (2000). Global Development Research Centre.

  http://www.gdrc.org/icm/environ/environ.html. This is a larger document on environmental assessment of microenterprises, but includes a case study of brickmakers in Zimbabwe.

- *Vertical Shaft Brick Kiln Fact Sheet*. Development Alternatives Inc.

  http://www.devalt.org/da/tsb/vsbk.pdf. This fact sheet discuses vertical-shaft brick kiln (VSBK) technology and provides contact information for further inquiries and technical material.

- *The Vertical Shaft Brick Kiln.* Wall Technical Brief. German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/vertical.htm. Description of VSBK technology first implemented in China and India. Also contains a short discussion covering the advantages of the technology—lower fuel usage, low maintenance and low smoke. Includes diagrams and figures.

- *Bull's Trench Brick Kiln*. Wall Technical Brief. German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/bull.htm. Description of the Bull’s Trench Brick Kiln technology. Discusses advantages and disadvantages of the technology, with specific reference to lowering fuel use and improving productivity. Includes diagrams and figures.

- *Brick Clamps.* Wall Technical Brief. German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/brickclamps.htm. This technical brief explains the oldest and most traditional methods for firing bricks in field clamps. It compares wood and coal fired clamps, shows the advantages and disadvantages of brick clamps and addresses how the efficiency of these kilns can be improved.

- *Hoffman Kilns*. Wall Technical Brief. German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/hoffmannkilns.htm. A description of the Hoffman Kiln technology. The brief discusses advantages and disadvantages of the technology and possible improvements in efficiency.

- *Bibliography on Using Waste in Fired-Clay Brick Making*. basin/GATE and German Federal Ministry for Economic Cooperation and Development (GTZ).

  http://www.gtz.de/basin/gate/biblio02/biblio02.zip. This bibliography lists general publications on the use of waste in brickmaking. It has different chapters on the use of agricultural and forestry wastes, industrial wastes, and municipal and household wastes. Most documents can be purchased for under US$20; the document also offers some useful contact addresses.

- Andrew Scott. *The Environmental Impact of Small Scale Industries in the Third World*. Global Environmental Change Programme Briefings No. 19.

http://www.susx.ac.uk/Units/gec/pubs/briefing/brief-19.pdf. This technical brief includes a short discussion of the environmental impacts associated with small-scale brickmaking.

- *Energy Conservation in the Ceramic* Industry (1994). United Nations Industrial Development Organization (UNIDO).

  http://www.unido.org/userfiles/PuffK/ceramic.pdf. This report covers the broader ceramics industry, including pottery, but contains a useful detailed discussion of how to improve energy efficiency in kilns.

- *Cleaner Brick Production in India: A Cross-Sectoral* Initiative (1999). Basin news No. 18. SKAT.

  http://www.gtz.de/basin/news/magazine/basinnews_18.pdf. A case study of the brick industry in India—includes a comparison of CO_2 emissions for different kiln types as well as other workplace enhancing measures. Contains a schematic drawing of VSBK technology.

- Maithel, Sameer, Heini Mueller and Rajinder Singh (2000). *Experiences in the Transfer and Diffusion of Efficient Technologies in the Indian brick industry.* CTI/Industry Joint Seminar on Technology Diffusion in Asia 14-15 January 2000. United Nations Framework Convention on Climate Change Secretariat.