Chapter 4.5 Wet Textile Operations: Cleaner Production Fact Sheet and Resource Guide

Purpose

This fact sheet offers basic information on the important adverse environmental impacts of wet textile operations, 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 organizations seeking more information.[9]

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 Part II 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 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

[9] 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 production, 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

- Water use
- Chemicals
- Improper utilization and poor maintenance of machinery and equipment
- Poor production practices
- Inefficient energy use
- Wastewater

Adverse Environmental Impacts and Mitigation Opportunities

Several key environmental impacts associated with wet textile operations are listed in the box at left 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.

❑ *Water use*

Wet textile production requires water at almost every stage of the production process. If well or pump water is used, excessive water use can deplete water sources for future production or community use. Energy costs for pumping, as well as environmental impacts from energy consumption, will be higher than necessary. Excessive water use can lower the water table and require frequent redrilling of wells.

If the enterprise pays by volume for the water it uses, reducing water usage can be expected to provide substantial savings. Using water more efficiently guarantees less costly production and reduces the risks of water shortages that could interrupt production.

Key questions to consider:

- Is water left running when it is not in use?
- Is fresh water used in every stage of production? Could some water be reused?
- How much money do you pay for water, and how much could you reduce that cost through more efficient use?

Selected mitigation strategies:

- Reuse water from "cleaner" stages of production in "dirtier" stages of the next production cycle. For example, use rinse water from the final stage of production in the first stage rinsing of the next batch.
- Decrease water usage through "dry cleanup." Dry cleanup involves initial cleaning without water (by sweeping or wiping down) before washing. This method reduces the amount of water required to dislodge solid or semi-solid wastes from floors or machinery.
- Regulate water flow. Using high-pressure water hoses can ease cleaning and cut water use; often this can be accomplished simply by adding a new nozzle to the end of a hose.
- Limit water loss between production stages. Turn off water when transferring materials from one bath to another, since leaving the water running causes substantial water loss. Prevent baths from overflowing by monitoring water levels closely or installing an automatic shut-off mechanism.

❑ *Chemicals*

Chemical dyes and solvents may represent a significant part of production costs; costs rise if chemicals are overused due to inefficient production methods. Excessive chemical use increases risks of contamination and may affect the health of workers. Efficient chemical use results in lower production costs and lower environmental impacts.

Key questions to consider:

- Where are chemicals stored? In what quantities?
- Are workers trained in correct measurement and application techniques?

- Are different kinds of chemicals available for the same application? Are any more efficient, safer, or less harmful to worker health or the environment?

Selected mitigation strategies:

- Improve chemical application techniques. Spot-apply solvents instead of pouring; this helps avoid spills and stops excessive chemical use. Use correct measurements to reduce waste or spoilage.
- Consider using less dangerous or damaging chemicals. Replace potentially carcinogenic (cancer-causing) chemical inks with vegetable-based inks. To reduce pollution, use lower-foaming detergents or solvents with less isopropyl alcohol.
- Reuse certain chemicals. Investigate which chemicals can be reused or recycled. Caustic soda, for example, can be recaptured from the mercerizing process (an intermediate step in textile refinishing) through evaporation.
- Improve chemical storage. Monitor storage area for signs of chemical leakage. Make sure containers are well built and have no cracks.

❑ *Improper use and poor maintenance of machinery and equipment*

Improper use of machinery or equipment can increase waste, raising costs for inputs and, often, for waste disposal. Chemical or fuel leaks from machinery waste energy, can contaminate water supplies, and may threaten workers' health. Better management of machines and equipment lowers costs and reduces losses.

Key questions to consider:

- How well are workers trained in machine operation and maintenance?
- Are machines used to their full capacity?
- Is equipment well maintained? Is there a regular maintenance schedule and checklist?

Selected mitigation strategies:

- Train workers in proper machine maintenance and operation. Use machines at full capacity. This increases output and saves fuel.
- Use appropriately sized equipment. Equipment that is too large wastes water; equipment that is too small may lead to excessive waste and spills.

- Minimize leakage and blockage in equipment. Monitor machinery to prevent fuel or water leakage; clean debris from sumps and screens to improve efficiency.

❑ *Intermittent production*

Intermittent textile producers—job shops that produce textiles on a contractual basis—face production inefficiency and pollution problems similar to those of permanent producers, but these are made worse by the temporary nature of production. Forward planning can lessen waste that occurs in between production stages and reduce some of the inefficiencies.

Key questions to consider:

- How unpredictable are production requests? Do they follow a pattern?
- How are inputs or machinery stored in between production cycles?

Selected mitigation strategies:

- Increase production efficiency through improved recordkeeping. Documenting production requests helps producers determine if there are any general production trends over time and makes it easier for producers to anticipate demand. Maintaining a logbook of inputs also allows producers to check stocks and replace inputs if they are no longer effective.
- Maintain equipment even if it not in use. Check equipment for leaks and repair immediately so that production will not be delayed when restarted. Ensure that chemicals and dyes are stored in tightly sealed containers that do not leak.
- Plan input purchases to minimize leftovers (of chemicals, materials, etc.) once production has ended. Use minimum amounts of chemical or fuel inputs to increase efficiency and reduce losses in between production stages.

❑ *Working conditions*

Textile production may result in hazardous working conditions—excessive heat caused by operating machinery, lack of ventilation, skin-irritating chemicals—that can damage workers' health. An unhealthy workforce can lower productivity, cause excessive absences and make costly mistakes.

Key questions to consider:

- What kinds of fumes are produced in the different stages of production?

- Are there any by-products from production that cause skin, eye or breathing irritation, even occasionally?
- Are any of the chemicals used known to be potentially carcinogenic?
- Are gloves, boots, face masks or other protective clothing available for workers?

Selected mitigation strategies:

- Develop and implement a health and safety plan. Sometimes small changes such as buying face masks or rubber gloves can dramatically reduce potential harm to workers. Find ways of preventing accidents.
- Train workers in accident prevention. Designate one person as the safety trainer and have that person train others. Check existing safety equipment regularly; replace elements like filters frequently.
- Provide tight-fitting covers for chemical baths, to reduce sickening fumes and minimize evaporation of costly chemicals.
- Increase ventilation inside buildings and around chemical baths. Fumes from chemicals, even if the chemicals are outside, can sicken workers. Inside, increase ventilation by improving the buildings layout. Outside, orient chemical baths downwind of workers and other production areas. The use of fans, covers and/or chimneys can help minimize fume inhalation outdoors or indoors.
- Consider reorganizing production, such as by rotating shifts, so that individual workers do not spend too much time at once exposed to fumes.

❑ *Poor production practices*

Some common production practices reduce resource efficiency and cause more pollution. For example, using too much salt in color fixing and from inaccurate color matching results in both a significant waste of inputs and added water pollution. Salt is particularly damaging to water sources used for drinking water and agriculture, and can be difficult and/or expensive to remove from wastewater. Modifying textile production in simple ways can reduce environmental harm, lower costs and raise output.

Key questions to consider:

- How well are workers trained in production methods?
- Can two stages of production be combined into one?
- Where can improvements be made in the production process?

Selected mitigation strategies:

- Improve machine efficiency. Controlling draft and firing techniques in boilers save fuel and improves production time.
- Train workers in proper use of salts and dyes. Require all workers to measure salts, and provide simple measuring equipment, e.g., measuring cups. To prevent wasting material from a bad dye mix, use a small test batch to determine whether a dye will yield the desired colors.
- Investigate alternative production strategies. Using hot water instead of cold to process fabric can save a scouring stage; note, however, that this may result in higher fuel costs. Improving the scouring process can reduce alkali consumption.
- Institute housekeeping measures to speed production, such as putting screens on drains, preventing boil-overs and improving the vessels in which dyeing takes place to avoid leaks.

❑ *Inefficient energy use*

Most energy used in textile production occurs in heating dye baths, rinsing and drying fabrics. Inefficient use or overuse of fuel during these production stages contributes to pollution and higher operating costs. Reducing use can save costly or scarce resources.

Key questions to consider:

- What type of fuel is used in production? In what quantities?
- What various fuel sources are available in your area? At what cost?
- Which production stages use the most fuel?

Selected mitigation strategies:

- Use alternative fuel types. Organic wastes, such as rice husks and bagasse, can supplement scarce fuel sources such as wood. Renewable energy sources, such as solar hot water heating or photovoltaic (solar) cells, may be a cost-effective option in some cases, but cost, availability and applicability of the technology should be carefully assessed.
- Improve heat transfer and insulation. Insulate pipes and bath containers to reduce energy loss and decrease fuel needs.
- Regulate fuel use to meet needs. Use only enough fuel to meet production requirements.
- Implement energy conservation methods. Use a thermometer to maintain the most efficient bath temperature. Make more efficient use of production time, and prevent excessive use of fuel (due to

overheating or reheating baths). Consider planning production cycles to reuse preheated baths.

❑ *Wastewater*

Wastewater from textile production is often contaminated with chemical dyes, solvents or salts. Contaminated water presents a health danger to workers and the surrounding community. Wastewater can also gather in stagnant pools and create breeding grounds for insects, particularly mosquitoes. In the long run, contaminated wastewater can make the local water supply undrinkable and ruin local farmers' crops. These problems may force textile operations to pay for procuring clean water from other locations or to clean the water on-site before using it

Key questions to consider:

- Where is wastewater discharged?
- What treatment methods are currently used in production?
- What kinds of chemicals are used and what dangers do they pose?

Selected mitigation strategies:

- Separate chemically contaminated water from organic wastewater. Water with undyed fibers or dirt in it does not present a health hazard and can even be used as fertilizer. Some type of water treatment approach will be required to render chemically and otherwise contaminated water safe for release into the environment. Consult with an expert to determine what treatment methods are appropriate for the individual facility's wastewater.
- Minimize contaminated water. Ensure that dyes or chemical-coated materials are cleaned away from water sources and with as little water as possible.
- Avoid spills that can contaminate water supplies.

Resources and References:

- *Sectoral Profile of the Textile Industry* (1998). United Nations Industrial Development Organization (UNIDO) Sustainable Development Program. January.

  http://www.unido.org/ssites/env/sectors/sectors701.html. An extensive overview of textile production including subsectors. Also includes a very detailed technical description of cleaner production techniques such as chemical substitution, water conservation and waste minimization.

- *Energy Conservation in the Textile Industry* (1992). United Nations Industrial Development Organization (UNIDO) and Ministry of International Trade and Industry (MITI), Japan.

  http://www.unido.org/userfiles/PembletP/sectorstextile.pdf. This manual presents a lengthy discussion of textile production in a variety of subsectors—yarn and fiber production, knitting, weaving, clothing, dyeing and finishing—and provides guidance on energy saving technologies for each one.

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

  http://www.cleanerproduction.com/industries/textiles.html. A short discussion of cleaner production issues and a checklist of possible areas of attack. This Web site also includes links to a number of other textile sites.

- *UNEP Textiles Working Group on Cleaner Production.*

  http://www.emcentre.com/textile/index.htm. A large Web site with access to cleaner production techniques and examples. Includes the case study *EP3—Pollution Prevention Assessment for a Textile Dyeing Facility* (http://www.emcentre.com/unepweb/tec_case/textile_17/process/p7.htm) Login required.

- Cleaner Production in Cloth Printing and Dyeing Operations

  http://www.emcentre.com/unepweb/tec_case/textile_17/process/p13.htm. Useful description of general cost-effective pollution prevention tips (ranging from limiting chemical use to saving water or fuel costs).

- "Textiles" (1998). *Pollution Prevention and Abatement Handbook.* World Bank Group.

  http://wbln0018.worldbank.org/essd/essd.nsf/GlobalView/PPAH/$File/81_text.pdf. This chapter is part of a larger pollution prevention handbook published by the World Bank. The document discusses major sources of pollution and lists technical requirements for limiting chemical pollutants.

- *Water Conservation for Textile Mills: A Waste Reduction Fact Sheet*. North Carolina Division of Pollution Prevention and Environmental Assistance.

  http://www.p2pays.org/ref/01/00026.htm. Methods of conserving water at various points in the production process. Although primarily aimed at large-scale producers, it contains a useful discussion on reuse and water conservation relevant to the small-scale producer.

- *The Textile Industry and the Environment* (1993). United Nations Environmental Program (UNEP) Technical Report No.16.

  http://www.uneptie.org/pc/cp/library/catalogue/related.htm. This booklet gives an overview of environmental impacts associated with textile production and strategies for cleaner production. For sale at earthprint.com for US$35.

- *India: Process Optimization in Textile Dyeing*. United Nations Industrial Development Organization (UNIDO) Sustainable Development Program.

  http://www.unido.org/ssites/env/ncpc/casestudy/casestudy3.html. This case study of a bleach and dye-processing operation in India describes strategies for cleaner production and improving operating efficiency.

- Smith, Brent and Vikki Bristow. *Indoor Air Quality And Textiles: An Emerging Issue.* Raleigh, North Carolina: School of Textiles, North Carolina State University.

  http://www.p2pays.org/ref/03/02906.pdf. Fairly technical discussion of possible air pollutants present inside textile processing buildings.

- *Cleaner Technology Transfer to the Polish Textile Industry: Idea Catalogue and Selected Options* (1999). Danish Cooperation for Environment in Eastern Europe (DANCEE).

  http://www.mst.dk/udgiv/publications/1999/87-7909-255-1/html/helepubl_eng.htm. This study was commissioned by the Danish environmental protection agency for improvements in the Polish textile industry. Although the report refers to medium-scale producers, it provides an excellent example of diagnosis and options for cleaner production. The report discusses different methods of improving resource efficiency, chemical substitution, and optimization.

- *Pollution Prevention Tips for Wet-Processing Textile Mills*. Georgia Pollution Prevention Assistance Division. Georgia Department of Natural Resources.

  http://www.dnr.state.ga.us/dnr/p2ad/pblcations/textile.html. This report gives specific cleaner production guidelines for improving textile processing. Concentrates mostly on water conservation methods and improving chemical use.

- Wanucha, David J. *Land Application of Textile Biosolids: North Carolina's Experience.* North Carolina Division of Pollution Prevention and Environmental Assistance.

  http://www.p2pays.org/ref/02/01124.pdf. A low-tech discussion of the beneficial reuse of textile wastewater treatment sludge in agriculture.