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WET TEXTILE OPERATIONS

RESOURCE EFFICIENT AND CLEANER PRODUCTION BRIEFING AND RESOURCE GUIDE FOR MICRO & SMALL ENTERPRISES

PURPOSE

Issue. Certain process, technique, and management deficits are commonly found in micro- and small-scale wet textile operations. These deficits can have serious adverse effects on short- or long-term business performance---AND, on the local environment and on community health and safety. Among the most significant areas where economic savings can be realized through cleaner production are management actions that address **excess water use, inefficiencies in the use of chemical inputs, poorly maintained equipment and production practices, poor planning for intermittent production, poor working conditions, inefficient fuel use, and excess/poorly treated wastewater.**

Response. Addressing these deficits by adopting resource-efficient and cleaner production (RECP) processes, techniques, and management practices can reduce costs and improve business performance and, at the same time, avoid or minimize adverse impacts on the local environment and on community health and safety. RECP approaches generally focus on improving resource and production efficiency which saves physical and energy resources, time, and money needed in production—and results in less waste and pollution. This briefing supports the application of RECP solutions in these seven key areas.

Contents. This briefing addresses each deficit area in turn. General business, environmental and health and safety issues are identified first. Then, a question and answer format is used to identify specific deficits and potential RECP solutions. The References and Resources section at the end of this briefing provides more detailed and quantitative information on these solutions.

Audience. This briefing is intended for business development services providers working directly with wet textiles, for those designing MSE strengthening projects, and for USAID staff (and the staff of other funding organizations) charged with overseeing projects in wet textile sector.

Scope. This briefing focuses on MSEs that are dying fabrics.

TABLE OF CONTENTS

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THE PROVEN BENEFITS OF RESOURCE EFFICIENT AND CLEANER PRODUCTION (RECP)

In 1990, UNEP defined Cleaner Production (CP) as "*The continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment*". The CP concept is widely accepted and promoted internationally, including by USAID. The strategies used to implement CP can be as simple as following the guidance in this briefing, or more complex and formal Environmental Management Systems (e.g., ISO 14001 standard) utilized by medium and large enterprises. UNEP is now advancing the concept of Resource Efficient and Cleaner Production, updating CP with additional emphasis on efficient utilization of resources in product and service enterprises.

This briefing is specifically concerned with RECP/CP technical and management interventions in production operations. Such interventions focus on (1) increasing the efficiency with which resources are utilized and/or (2) assuring that resources are utilized "cleanly"—without incurring costs and impacts that adversely affect the bottom line of the enterprise, the environment, and worker and community health and safety. Typical RECP interventions include:

- substituting different materials
- modifying processes
- improving process management
- upgrading equipment
- redesigning products

Inefficient use of resources like fuel, water and raw materials incurs both business and environmental costs. Experience shows that by reducing inefficiencies, RECP interventions in many cases substantially improve business performance AND deliver environmental, health and safety benefits—sometimes with little or no investment.

Is this always true? No. Some RECP interventions may not improve business performance. But RECP approaches offer the most cost-effective way to improve environmental or social performance when required by project implementation conditions, local regulations, or simply to preserve community goodwill.

For more information see http://www.usaidgems.org/sme.htm.

AREA 1: REDUCE WATER USE

Business Issues: Wet textile production requires water at almost every stage of the production process. If the MSE pays by volume for water, reducing water usage can be expected to provide substantial savings. Energy costs for pumping, as well as environmental impacts from energy consumption will be higher than necessary. Using water more efficiently guarantees less costly production and reduces the risks of water shortages that could interrupt production.

Environmental Issues: Excessive water use can lower the water table or reduce surface water availability to other users.

Community and Occupational Health and Safety Issues: If well or pump water is used, excessive water use can deplete water sources for future production or community use and require frequent redrilling of wells. Excessive surface water use can affect availability for downstream users.

Use the following questions and answers to identify specific shortcomings in excess water use and the corresponding RECP methods that address them.

Is water left running when it is not in use?

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. If the only shut-off device for a water hose is at its connection to the wall, consider adding an additional mechanism to shut off the hose at the mouth of the hose. Prevent baths from overflowing by monitoring water levels closely or installing an automatic shut-off mechanism.

Do you use hoses to clean the facility?

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.

Use high-pressure water hoses to ease cleaning and cut water use; often, this can be accomplished simply by adding a new nozzle to the end of a hose.

Is fresh water used in every stage of production? Could some water be reused?

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 one production cycle in the first-stage rinsing of the next batch.

AREA 2: INCREASE EFFICIENCIES OF CHEMICAL INPUTS

Business Issues: Chemical dyes and solvents may represent a significant part of production costs; costs rise if chemicals are overused due to inefficient production methods. Dyes and other chemicals from textile processing can be recycled and reused, saving resources and costs. Efficient chemical use lowers production costs.

Environmental Issues: Discharge of chemical wastes from dyes can be especially persistent in the environment with serious effects on soils and waterways, and the disruption of aquatic ecosystems.

Community and Occupational Health and Safety Issues: Excessive chemical use and associated discharge also increases risks of agricultural contamination and may affect the health of workers.

Use the following questions and answers to identify specific shortcomings in the use of chemical inputs and the corresponding RECP methods that address them.

Is there a system to track chemical inventory?

Avoid keeping outdated chemicals. Chemicals may lose their effectiveness if used past their expiration date, resulting in poor-quality products and wasted bath solutions.

Recently purchased chemicals should be used after older chemicals (a "first in, first out" policy) in order to prevent accumulation of expired stock. Creating an inventory control system will prevent waste by ensuring that all chemicals are used in order of arrival in the storeroom.

Label all chemical containers with the name of the chemical, the date it arrived at the storeroom, the name of the manufacturer/distributor, and any appropriate hazard warnings. The manufacturer, and in some cases the distributor, may be able to provide a Material Safety Data Sheet (MSDS), which includes necessary warnings as well as details about proper safety equipment and procedures for handling the chemical. Assistance providers may also be able to find MSDSs via the Internet.

Secure storage areas, and grant access to only a few designated employees.

Dyes and other chemicals from textile processing can be recycled and reused, saving resources and costs for micro- and small enterprises.

Require a one-for-one exchange policy, where workers must return an empty container in order to receive a new container. This will control the number of open containers, reducing the risk of spills, contamination and wasted materials.

Can chemicals be reused?

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.

Are workers trained in correct measurement and application techniques?

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, make a small test batch to determine whether a dye will yield the desired colors. Improve

chemical application techniques. Spot-apply solvents instead of pouring; this helps avoid spills and stops excessive chemical use.

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

Consider using less dangerous or damaging chemicals by replacing potentially toxic and carcinogenic dyes (such as 'azo' dyes and dyes that contain heavy metals) with plant-based dyes, and less-toxic synthetic dyes. See Chequer, F.M.D. et al. Intech, Chapter 6: Textile Dyes: Dyeing Process and Environmental Impact (2013).

AREA 3: MAINTAIN EQUIPMENT AND IMPROVE PRODUCTION PRACTICES

Business Issues: Improper use of machinery or equipment can increase waste, thus raising costs for inputs and waste disposal. Better management of machines and equipment improves efficiency and lowers costs.

A dye expert prepares dyes at the Gadim Guba production facility in Guba, Azerbaijan.

Environmental Issues: Changing textile production in simple ways can reduce environmental harm. Some common production practices use resources inefficiently and cause more pollution. For example, two common mistakes can cause unnecessary waste of inputs and extra water pollution: using too much salt in color fixing, and not properly matching colors among different batches. Salt is particularly damaging to water sources used for drinking water and agriculture, and can be difficult and/or expensive to remove from wastewater.

Community and Occupational Health and Safety Issues: Chemical or fuel leaks from machinery may waste energy, contaminate water supplies, and threaten workers' health.

Use the following questions and answers to identify specific shortcomings in equipment maintenance and process control and the corresponding RECP methods that address them.

Are machines used to their full capacity?

Run machines at full capacity whenever possible to increase output and save fuel. Use appropriately sized equipment. Equipment that is too large wastes water; equipment that is too small may also lead to waste and spills.

Is equipment well-maintained? Is there a regular maintenance schedule and checklist?

Improve machines' efficiency. Controlling drafts and improving firing techniques in boilers saves fuel and speeds production.

Train workers in proper maintenance and operation of machines. Minimize leakage and blockage in equipment. Monitor machinery to prevent fuel or water leakage; clean debris from sumps and screens to improve efficiency.

Institute housekeeping measures to speed production, such as putting screens on drains, using temperature controls to help prevent boil-overs, and sealing vessels in which dyeing takes place to avoid leaks.

Can two stages of production be combined into one?

Investigate alternative production strategies. For example, using hot water instead of cold water to process fabric can save a scouring stage. However, this may result in higher fuel costs. Improving the scouring process can reduce alkali consumption.

AREA 4: PLAN FOR INTERMITTENT PRODUCTION

Business Issues: 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. Unplanned intermittent production can result in large stocks of unused inventory and cash-flow issues.

Environmental Issues: Planning in advance can lessen waste that occurs in between production stages and reduce some of the inefficiencies.

Community and Occupational Health and Safety Issues: Intermittent production can affect workers' schedules and budgets. Providing workers with advance notice of changes in production can allow them to arrange for other work during periods of low production.

Use the following questions and answers to identify specific shortcomings in planning for intermittent production and the corresponding RECP methods that address them.

How unpredictable are production requests? Do they follow a pattern?

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.

Increase production efficiency through improved record-keeping. Documenting production requests helps producers determine if there are any general production trends over time (for example, during certain seasons) 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.

How are inputs or machinery stored in between production cycles?

Maintain equipment even if it is not in use. Check equipment for leaks and repair immediately so that production will not be delayed when it restarts. Ensure that chemicals and dyes are stored in tightly sealed containers that do not leak.

AREA 5: IMPROVE WORKING CONDITIONS

Business Issues: Improving working conditions can be important to the health of workers. Unhealthy workers may be less productive, miss work too often and make costly mistakes. Working conditions that guard workers' health and safety can help to increase productivity, lower costs, and make a small enterprise a better neighbor to the community

Environmental Issues: Preventing the generation of fumes, dust, and other workplace hazards may also reduce their dispersal into the environment.

Working conditions that guard workers' health and safety can help to increase productivity, lower costs, and make a small enterprise a better neighbor to the community.

Community and Occupational Health and Safety Issues: Textile production may result in hazardous working conditions that can damage workers' health, including: excessive heat caused by operating machinery, lack of ventilation, and skin-irritating chemicals.

Use the following questions and answers to identify specific shortcomings in working conditions and the corresponding RECP methods that address them.

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

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. Indoors, install vents and fans and/or change the building's layout to improve ventilation. Outside, orient chemical baths downwind from workers and from 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.

What worker safety measures are in place?

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. Incorporate safety signage and safety awards programs.

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.

AREA 6: OPTIMIZE FUEL USE

Business Issues: Most energy used in textile production occurs in heating dye baths and in rinsing and drying fabrics. Inefficient use or overuse of fuel during these production stages contributes to pollution and higher operating costs. Inefficient production methods leading to excessive fuel consumption are typical. Excess fuel consumption increases fuel costs, which are often significant operational costs. In addition, a wet textile MSE that competes with local communities for fuelwood may find community opinion quickly turning against its operations.

Environmental Issues: Excess fuel consumption increases air pollution. If wood is used as a fuel, excess consumption may contribute to deforestation and associated environmental impacts.

Community & Occupational Health & Safety Issues: Increased air pollution, particularly from incomplete combustion, can cause and worsen respiratory illnesses in workers and the surrounding community. Depletion of fuelwood adversely affects communities, particularly women and girls collecting wood.

A woman selling cloth at a market.

Use the following questions and answers to identify specific shortcomings in fuel use and the corresponding RECP methods that address them.

What types of fuel are currently used to fire boilers? Are these fuels being used faster than they regrow? Are there other, more abundant sources of fuel available?

If the current fuel source is becoming scarcer/more expensive, look for alternative fuel types, such as agricultural waste (crop residue such as corn stover, or processing waste such as sugar bagasse). Consider planting fast-growing local (indigenous) 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. If trees are planted, make sure it is clear who owns them to encourage better long-term management.

Is fuel wood protected from the weather?

A small increase in water content drastically reduces the usable energy that can be extracted from fuel. Make sure to store wood or other fuels in a well-ventilated space that protects it from the rain.

Are boilers and pipes used to heat chemical baths?

If so, MSEs could likely save energy and fuel by insulating the boiler and steam pipes. Clean heat transfer pipes periodically, especially where heat is picked up and dumped (i.e. boiler and chemical baths) to improve heat transfer. Insulate pipes, boilers and bath containers to reduce energy loss and decrease fuel needs. Assess opportunities to preheat boiler water with solar energy.

Is bath temperature measured and optimized?

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 the facility's production cycles to reuse bathwater that is still hot from a previous use.

AREA 7: REDUCE AND TREAT WASTEWATER

Business Issues: Treatment of and disposal of wastewater can be costly. Therefore, excess wastewater generation will result in excess treatment costs. Environmental Issues: Wastewater from textile production is often contaminated with chemical dyes, solvents or salts. Wastewater can also gather in stagnant pools and create breeding grounds for insects, particularly mosquitoes.

Community and Occupational Health and Safety Issues: Contaminated water endangers the health of workers and the surrounding community. In the long run, contaminated wastewater can make the local water supply undrinkable, unsafe for bathing or washing clothes, and ruin local farmers' crops.

Use the following questions and answers to identify specific shortcomings in wastewater generation and the corresponding RECP methods that address them.

Where is wastewater discharged?

Separate chemically contaminated water from organic wastewater. Water with undyed fibers or dirt in it does not present a health hazard. However, water that is contaminated by chemicals or other substances will need some type of treatment to make it safe for release into the environment.

What treatment methods are currently used in production?

Liquid wastes containing dyes and chemicals should not be discharged without treatment. First, to reduce treatment costs, minimize contamination of water during production. Ensure that dyes or chemical-coated materials are cleaned with as little water as possible. Consider filtering and reusing dyes and chemical solutions.

Explore evaporative or precipitative processes to treat unavoidable dye and chemical waste. This can concentrate the liquid waste into a solid form, which can be more economically disposed of (landfilled) compared to disposal of liquid waste. Otherwise, send liquid waste to a chemical treatment facility.

REFERENCES AND RESOURCES

- Ecotextile News. http://www.ecotextile.com.

  This magazine is an environmental magazine for the global textile and clothing supply chain.

- Textile consultancy Specialising in Dying, Finishing, Printing and Chemicals. http://www.colour-connections.com/.

  This website is of a consultancy dedicated to improving textile products, the processes used to make them, the technical knowledge of individuals, and the effectiveness of communication with suppliers and customers.

- Eco-metrics: A Tool Devised to Calculate the Environmental Impact of the Different Textile Types and Different Production methods. http://www.colour-connections.com/EcoMetrics/index.html.

  This website presents, Ecometrics, a tool devised to calculate the environmental impact of the different textile types and different production methods. It looks at the total life-cycle of a product and considers the impact on water, energy, use of non-renewable resources and pollution — and calculates and overall score for a particular product or process.

- Society of Dyers and Colourists. http://www.sdc.org.uk/.

  This website represents the Society of Dyers and Colourists, the world's leading independent, educational charity dedicated to advancing the science and technology of colour worldwide.

- Information on natural dyes: http://www.naturaldyes.org/organizations.htm.

  This website represents the Natural Dyes International, an international nonprofit organized to research natural dyes and pigments, share information, and educate the public about the history of this rich tradition and the use of these natural materials.School of UNESCO. Producer of Silk Vegetable Dyed, Hand Knotted Rug & Suzane.

- Zarina F. Kenjaeva (from Uzbekistan: Madrasa Nodir Devon Begi) demonstrates naturally dyed carpets at the Folk Art Market in Santa Fe, New Mexico.

- Ethical Fashion Forum http://source.ethicalfashionforum.com/.

  This website represents the Ethical Fashion Forum, which in 2011 launched SOURCE, a ground breaking social enterprise set to transform livelihoods for 2.5 million people in the developing world and significantly reduce the environmental impact of the fashion industry.

- Chequer, F.M.D. et al. Intech. Chapter 6: Textile Dyes: Dyeing Process and Environmental Impact. (2013). http://www.intechopen.com/books/eco-friendly-textile-dyeing-and-finishing/textile-dyes-dyeing-process-and-environmental-impact.

  Focuses on various genetic disorders addressing epidemiology, etiology, molecular basis and novel treatment options for these diseases

- Cleaner Production in Cloth Printing and Dyeing Operations. Submitted to UNEP IE by the Sino-Norwegian Cleaner Production Program. It was edited and formatted for the ICPIC diskette in May 1997. Subsequently it underwent a formal technical review in September 1998 by Dr. Prasad Modak, Environmental Management Centre, Mumbai, India. http://www.p2pays.org/ref/10/09351.htm.

  Useful description of general cost-effective pollution prevention tips (ranging from limiting chemical use to saving water or fuel costs).

- Cleaner Technology Transfer to the Polish Textile Industry: Idea Catalogue and Selected Options (1999). Danish Cooperation for Environment in Eastern Europe (DANCEE). http://www2.mst.dk/udgiv/Publications/1999/87-7909-255-1/pdf/87-7909-265-9.pdf.

  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.

- 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/fileadmin/import/userfiles/puffk/textile.pdf.

  This manual presents a lengthy discussion of textile production in a variety of subsectors-yarn and fiber production, knitting, weaving, dyeing and finishing-and provides guidance on energy-saving technologies for each one.

- Pollution Prevention Tips for Wet-Processing Textile Mills. Georgia Pollution Prevention Assistance Division. Georgia Department of Natural Resources. http://www.p2pays.org/ref/09/08015.htm.

  This report gives specific cleaner production guidelines for improving textile processing. Concentrates mostly on water conservation methods and improving chemical use.

- Sectoral Profile of the Textile Industry (1998). United Nations Industrial Development Organization (UNIDO) Sustainable Development Program. January. http://www.p2pays.org/ref/11/10489/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.

- Smith, Brent and Vikki Bristow. Indoor Air Quality And Textiles: An Emerging Issue (1994). 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.

- "Textiles" (1998). Pollution Prevention and Abatement Handbook. World Bank Group. http://elibrary.worldbank.org/content/book/9780821336380.

  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.

- The Textile Industry and the Environment, Technical Report No.16. (1993). United Nations Environmental Program (UNEP).This booklet gives an overview of environmental impacts associated with textile production and strategies for cleaner production. 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.

- Water Conservation for Textile Mills: A Waste Reduction Fact Sheet (1993). 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 produce.