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FOOD PROCESSING

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 food processing 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 **unhealthy working conditions, excess water use, poor process control, inadequate machinery maintenance, and liquid and solid wastes.**

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 five 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 food processing MSEs, for those designing MSE strengthening projects, and for USAID staff (and the staff of other funding organizations) charged with overseeing projects in the food processing sector.

Scope. This briefing focuses on MSEs that are processing agricultural inputs into finished food products.

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LAST FULL UPDATE MAY 2013

This document was prepared by The Cadmus Group, Inc. under USAID's Global Environmental Management Support Program, Contract Number GS-10F-0105J. The contents are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the United States.

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: IMPROVE WORKING CONDITIONS

Business Issues: Poor working conditions can damage workers' health. An unhealthy workforce may be unproductive, miss work often and make costly mistakes.

Environmental Issues: Inadequate attention to worker sanitation can have significant adverse effects on both the heath of workers and on consumers.

Community and Occupational Health and Safety Issues: Certain working conditions—excessive heat caused by operating machinery, lack of ventilation, skin-irritating acids from fruits—can damage workers' health.

Afghan women sort raisins for early markets in Afghanistan and throughout Asia.

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

Do workers and managers know safety measures well?

Maintain safety equipment and reinforce safety training. Safety measures may already be in place, but workers should be reminded often. Designate one person as the safety trainer and have that person train others. Check existing safety equipment regularly, and replace elements like dust filters frequently. Provide safety and hazard signage with short clear instructions and strong visual content.

Are there any by-products from production that cause skin, eye or breathing irritation, or potential hearing impairment even occasionally?

Develop a personal protection equipment (PPE) plan and budget. Ensure appropriate PPE (e.g., gloves, boots, face masks, earplugs) is provided to workers, as needed.

Find ways of reducing harmful byproducts. For example, clean the floors in between production cycles to get rid of excess dust, or install drip trays to catch acidic fruit juice.

Prepare a prevention strategy for avoiding accidents. Sometimes small changes such as buying a face mask or rubber gloves can dramatically reduce incidences of harm to workers.

AREA 2: REDUCE WATER USE

Business Issues: Excess water use may also mean that water costs are unnecessarily high. Food processing requires water in almost every stage of production, but certain production methods or machinery can lead to overuse. Food processing workers sometimes use too much water, usually when they are cleaning equipment or food materials. Energy costs for pumping, as well as for environmental impacts from energy consumption, will

also be higher than necessary. Excessive groundwater use may lower the water table and require frequent redrilling of wells.

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

Environmental Issues: If excessive well or pump water is used for food processing, water sources for future production or community use could be depleted. New wells may have to be drilled more frequently as groundwater levels drop.

Excessive use of surface water may reduce availability for downstream users.

Community and Occupational Health and Safety Issues: Excess water use may not only cause others in the community to have less water, but also lessen the MSE's own future access to water. Untreated wastewater (effluent) from food processing operations may contain large quantities of organic material which can both pollute local water sources and degrade water quality for downstream communities.

Use the following questions and answers to identify specific opportunities to reduce water use and the corresponding RECP methods that address them.

Fruit and vegetable producers in Moldova observe a washer machine during a study tour.

Does the business primarily use water to clean machinery and floors?

Decrease water usage through "dry cleanup." Dry cleanup involves an initial cleaning without water (sweeping, wiping down) before washing. This method reduces the amount of water required to dislodge solid wastes from floors or machinery.

Is the source of water limited?

Regulate water flow and reuse water. Using high-pressure water hoses can ease cleaning and cut water use; usually this only involves adding a new nozzle to the end of a hose. Reuse water from "cleaner" stages of production in "dirtier" stages of the next production cycle. Some food processors use steam to purify or clean packaging materials; a closed-loop system can cycle hot water back into the system. This process saves both water and energy costs.

Is water left running when it is not in use?

Turn off water when not in use. 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.

AREA 3: IMPROVE PROCESS CONTROL

Business Issues: Large quantities of finished food product may be discarded due to improper food processing and low-quality inputs. This decreases output and increases waste disposal costs. Better use of technology and training will increase productivity and efficiency while reducing costs and waste.

Environmental Issues: A higher fraction of unusable product means that in order to produce the same amount of useful product, the MSE requires more production (with associated environmental impacts such as solid waste dumping and discharge to surface waters, and additional indirect effects on agricultural, forest and landscape resources per unit of finished, usable product.

Community and Occupational Health and Safety Issues: Increased spoilage causes more solid and liquid waste production and less profitability, with adverse impacts on nearby communities and downstream water supplies. Contamination may result in health problems for consumers.

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

Workers inspecting fruit to be turned into marmalades, sauces, and processed foods.

How are incoming ingredients inspected?

High quality products require good quality ingredients. Ingredients that are contaminated in a way that will not be addressed by processing should be returned unused (with better quality guaranteed by suppliers). For example, fresh fruit that is to be processed into dried fruit should not be accepted if it has insect infestation, and the processing procedure cannot trim/discard infested fruit adequately.

Recently purchased ingredients should be used after older ingredients (a “first in, first out” policy) in order to prevent accumulation of expired stock. A well-managed inventory control system prevents waste by ensuring that all ingredients are used in order of arrival in the storeroom.

Is the quality of supply water sufficient for human consumption?

Water used to rinse/wash food that is processed by the MSE should be free of chemical and microbial contamination. If source water of unknown quality is used, water should be regularly tested to ensure that it is suitable for human consumption. If contaminated, the MSE should consider using an alternative water source that is less likely to be contaminated, such as using well water, or installing a water filtration system.

Is there an opportunity to make changes to the building structure?

If the MSE is planning to construct or renovate a building, the buildings features could be customized during the planning stage to optimize it for food processing. Clear out vegetation in close proximity to the building, to reduce available habitat for pests, including insects and rodents. Make it easier to

clean by rounding over right angle joints such as where the floor meets the wall, and by using tiles or waterproof paint on floors and walls. Slope floors slightly towards central drains to make washing easier. Locate toilet facilities as far as possible from the part of the building that processes food, to reduce cross-contamination. Locate equipment or processing stations so that re-contamination (from dirt, dust, bacteria in raw meat, etc.) will not occur with products that have been cleaned and sanitized.

How open are structures to the outside elements and pests? Can they be closed off more effectively while maintaining sufficient ventilation?

Ensure that the building structure is secure not only from people but also from animals, birds and insects. Screens should be placed over drains, windows, and any other gaps (such as between the walls and roof) to keep out disease-carrying rodents and flies. Rodents can also gain access to the building by crawling along power lines. Protect power lines by installing discs on them, at least 25 centimeters in diameter. Storage areas should be well-ventilated and large enough so that excessive heat and moisture do not spoil fruits and vegetables.

What sanitation procedures should be in place?

The processing building should be thoroughly cleaned at the end of each day (possibly more frequently, depending on production volume). Adequate time should be allowed for this at the end of the workday, and each worker should have specific areas for which they are responsible. Wastes and scraps should be removed frequently (at least once a day), so as to avoid creating breeding grounds for pests.

If the MSE processes only dry ingredients (e.g., flour), it may be sufficient to sweep and dust the facility. Otherwise, the facility should be cleaned in two stages; first detergent-based cleaners to remove food residue, and then sterilizing agents (such as a dilute chlorine solution) to kill any remaining germs.

Local farmers in Kandahar Province, Afghanistan preparing pomegranates for export.

Are measures in place to ensure high standards for worker hygiene?

Even with the above methodologies in place, food still can be contaminated easily if the workers handling it are not following sound hygiene practices. Ensure that workers handling food processing products wear disposable gloves.

Workers should be trained (and checked on, and reminded periodically) to wash hands with soap before beginning any work that involves food handling, and after using the toilet. Provide health and sanitation signage with strong visual content, including requirement that employees wash hands after every toilet/latrine visit. Ensure that a regular schedule is followed and logged for cleaning toilets.

Workers should not smoke, spit, or eat within the parts of the facility where food processing takes place.

Sick workers should not be allowed to handle food. To ensure workers do not hide illnesses, sick workers should be granted paid leave, or be given other tasks that do not interact with the food processing line.

AREA 4: MAINTAIN MACHINERY

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.

Environmental Issues: Machinery that leaks process chemicals or fuel wastes resources, and can contaminate soil and water resources. This is especially true for diesel fueled boilers and vehicles.

Community and Occupational Health and Safety Issues: Poorly maintained machinery is more likely to break and cause injury to workers operating the equipment. Machinery that leaks chemicals or fuel can threaten workers' health.

Use the following questions and answers to identify specific shortcomings in the maintenance of machinery and the corresponding RECP methods that address them.

Meat packers prepare beef for export at the Botswana Meat Commission's abattoir in Lobatse, Botswana

Is machinery regularly maintained?

Schedule regular machine maintenance checks and repairs. Ensure that workers have up-to-date training in operation and maintenance. Do not wait until machinery is broken before checking it; leaks can occur long before serious equipment breakdown and may be costing the business money. As machinery is replaced, make an effort to replace faulty machinery with more efficient machinery.

Are there any routines or technology in place to detect leaks?

Regularly check for leaks, if possible this can be incorporated into the regularly scheduled maintenance routine. Repairing leaks lowers fuel costs and can prevent costly accidents such as fire. For dairy processors, who use more machinery and refrigeration systems than other food processors, reducing leakage can save money spent on refrigerants and other chemicals.

If machinery is difficult to access, then monitor wastes or emissions to detect leaks. For example, check for puddles underneath machinery or chemical/fuel smells.

When leaks are detected, use wood shavings, drop cloths and/or oil-water separators to catch spills and leaks.

Are fuel storage and filling areas well designed and managed?

Ensure concrete pads, berms and catchment areas for fuel delivery, storage and filling are designed to effectively prevent spillage, and any potential soil and water contamination. Provide appropriate PPE and training in fuel handling health, occupational and fire safety for workers responsible for fuel for boilers and vehicles.

Are there some aspects of the production process that are much louder than others?

Maintain and lubricate machinery so that excessive grinding or squeaking is minimized. This may increase the machinery's efficiency and make it last longer. Provide ear plugs or other hearing PPE for employees working with equipment that emit high levels of noise, or in areas with high decibel background noise.

AREA 5: REDUCE LIQUID AND SOLID WASTE

Business Issues: Food processing creates substantial amounts of organic and inorganic wastes. This can lead to increased costs for supplies, labor and sometimes fees for waste disposal. In addition, high volumes of burdensome waste, whether placed in a landfill or treated and disposed of, may place a serious strain on limited land resources. Minimizing waste can save on the cost of supplies and labor needed for waste disposal. Converting waste to productive uses can provide an extra source of income.

Solar dryers in India enable farmers to turn excess produce into food and income off-season.

Additionally, meat processing creates a good deal of liquid waste—wastewater with blood or animal fats—that may coagulate and clog pipes, or contaminate sources of water, and create noxious odors. Liquid wastes can also gather in stagnant pools, creating breeding grounds for insects. These conditions may cause costly losses in labor and meat production, potentially spread disease among workers, animals, consumers and nearby communities.

Environmental Issues: Food processing wastes can include microbial contaminants and high concentrations of organic material, wastewater with cleaning chemicals, blood or animal fats. These wastes may be disposed of in pits or ponds which can leach into groundwater and affect water quality. These wastes may also affect soils in the vicinity of the MSE. Wastes discharged to surface waters can also have significant downstream impacts on the environment and ecosystem services. Contamination of water sources and soils may not occur immediately, but can increase or accumulate over time, with damaging impact.

Community and Occupational Health and Safety Issues: Food processing may result in significant solid or liquid waste accumulation, outflows to surface water with adverse effects on communities and health and safety. These impacts, as well as excessive noise or odors, can affect the quality of life for communities in the vicinity or downstream from the production site. Community members may be unwilling to tolerate continued production or may block plans to expand production in the future.

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

How can production processes be changed to reduce waste?

Practice water reduction strategies mentioned above, including "dry cleanup," to minimize the amount of wastewater created and the amount of waste materials in the wastewater.

Minimize wastes by improving production processes. Identify and change elements of production that may be inefficient or produce excess waste. For example, improved techniques for peeling fruit could result in less flesh being removed with the peel, thus yielding more product.

Separate fats, grease and solids from wastewater. Oil separators or oil traps can be purchased or made at relatively low cost and can dramatically reduce the amount oil in wastewater. Drain stagnant pools of liquid or water away from holding pens and working areas. Fats and grease can be processed to be reused as lubricants or industrial fuel.

What waste treatment systems are in place?

Consider constructing waste treatment ponds. Both solid and liquid waste can be treated in these ponds, which can aid decomposition and reduce disposal costs. Ensure they are large enough to accommodate the volume of waste that is produced—if they are too small, the effectiveness of the treatment decreases and smell increases.

How close is the waste site to human settlements, surface water bodies or groundwater sources (e.g., wells)?

Locate waste disposal sites far away from housing/town centers and surface or groundwater water sources as they may attract disease vectors including insects, mammals and birds or breed mosquitoes. If the MSE stores waste temporarily before transporting it to a treatment facility or landfill, make sure it is not leaking into the ground. Instead, solid wastes can be stored on a concrete pad or in a lined pit. Liquid wastes can be held in lined treatment ponds.

Are there any other uses for organic waste generated by the production process (such as conversion to fodder or compost)?

If the MSE is disposing of organic and chemical wastes separately, ensure that chemical or fuel waste does not contaminate the organic waste. Dispose of chemical waste in a way that prevents chemicals from leaching into ground or surface waters (such as clay- or concrete-lined pits).

Assess whether a portion of the organic waste stream can be converted to compost or higher value products including fodder, fuel or fiber[1].

Conversion of the remaining portion of the waste stream into compost/fertilizer can be modified to facilitate faster decomposition/breakdown of organic material. Add layers of dirt and dry organic material to waste pits, or spread waste over large areas of land. This type of composting and "land spreading" can speed up decomposition and quickly lower waste volume. Ensure, however, that this material does not attract disease-carrying vectors including birds, rodents and insects.

REFERENCES AND RESOURCES

- Cleaner Production Assessment in Dairy Processing. United Nations Environment Program, Division of Technology, Industry and Economics (UNEP-TIE). http://www.unep.fr/shared/publications/pdf/2480-CpDairy.pdf.

  A guide to the application of cleaner production in the dairy industry, with a focus on the processing of milk and milk products at dairy processing plants.

- Cleaner Production Assessment in Meat Processing. United Nations Environment Program, Division of Technology, Industry and Economics (UNEP-TIE). http://www.unep.fr/shared/publications/pdf/2482-CPmeat.pdf.

  This document is a guide to the application of cleaner production to the meat processing industry, with a focus on the slaughtering of cattle and pigs at abattoirs. Includes case studies, sample evaluation, and assessment forms.

- Crickenberger, Roger G. and Roy E. Carawan (1996). Using Food Processing By-Products for Animal Feed. North Carolina Cooperative Extension Service. http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/cd37.html.

  This paper gives information to help food processors prevent pollution and save money by recovering by-products for use as animal feed. It considers some by-products suitable for animal feeding and factors to consider when selecting by-products for feed, e.g., moisture content, waste stream, volume of material, and effects on feed consumption.

- Fellows, Peter. Guidelines for Small-Scale Fruit and Vegetable Processors (1997). Agricultural Services Bulletin 127. UN Food and Agriculture Organization (FAO). http://www.fao.org/docrep/w6864e/w6864e0g.htm. (see appendix).

  This document generally concerns the production process, but it does also include a good overview of health and safety issues for fruit and vegetable processors. Specifically discusses methods for avoiding

[1] For example, some vegetable peelings can be used as animal fodder; the fiber from palm kernel husks can be sold to make rope or landscaping cloth.

dangers of hot liquids/jams, fruit acids and steam. Some mention of high volumes of solid organic waste and contamination of the product from workers.

- Fellows, P., B. Axtell, and M. Dillon (1995). Quality Assurance for Small-Scale Rural Food Industries. Agricultural Services Bulletin No. 117. UN Food and Agriculture Organization (FAO). http://www.fao.org/docrep/V5380E/V5380E00.htm.

  A good discussion of cleaner production building design. Specific mention of how to keep rodents and insects out of building structures in addition to sanitation and hygiene in production.

- Food Processing Fact Sheets (2011). Minnesota Technical Assistance Program, University of Minnesota. http://mntap.umn.edu/food/byproducts.htm.

  Although this site gives examples of cleaner production strategies undertaken by some Minnesota food processors, it is relevant to developing country producers. Links to the following fact sheets:

- Composting and Landspreading Food Processing By-Products. http://mntap.umn.edu/food/resources/78-CompLand.htm.

  A good discussion of how to compost commercial food processing wastes quickly through landspreading methods.

- Dairy Waste Reduction Tips. http://mntap.umn.edu/food/resources/Dairywaste.htm.

  A discussion of what some Minnesota dairy companies are doing to reduce wastewater and product losses. Includes 10 water conservation strategies.

- Feeding Food By-Products to Livestock. http://www.p2pays.org/ref/02/01247_files/fs77-r.htm.

  This fact sheet explains the conditions under which non-meat uncooked food by-products can be used as animal feed.

- "Fruit and Vegetable Processing" in Pollution Prevention Abatement Handbook (1998). World Bank. http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_fruitveg_WB/$FILE/fruitandvg_PPAH.pdf.

  General guidelines on reducing pollution, noise and effluent, with specific recommendations on the recirculation of water in production, dry cleanup, and reuse of organic wastes. Also includes technical information on requirements affecting effluent and acceptable levels of waste for specific items.

- Information Resources on Industrial Pollution Prevention (2000). United States Agency for International Development (USAID).

  Contains guides, case studies, and articles focused on pollution prevention in food processing and other sectors.

- International Cleaner Production Information Clearinghouse (1999). CD Version 1.0. United Nations Environment Program, Division of Technology, Industry and Economics (UNEP-TIE).

Contains case studies, country profiles, and cleaner production strategies for food processing.

- Destitution, Distortion, Deforestation (2008). UNEP. http://postconflict.unep.ch/publications/darfur_timber.pdf.

  Three reports detailing the environmental consequences and unsustainable nature of current brick-making practices.