WATER TRANSFORMED:

SUSTAINABLE WATER SOLUTIONS FOR CLIMATE CHANGE ADAPTATION

MODULE B: ADAPTING TO CHANGES IN WATER AVAILABILITY - INDUSTRIAL & COMMERCIAL SECTORS

This online textbook provides free access to a comprehensive education and training package that brings together the knowledge of how countries, specifically Australia, can adapt to climate change. This resource has been developed formally as part of the Federal Government's Department of Climate Change's Climate Change Adaptation Professional Skills program.

CHAPTER 3: IDENTIFYING & IMPLEMENTING WATER EFFICIENCY & RECYCLING OPPORTUNITIES BY INDUSTRY SECTOR

LECTURE 3.2: MANUFACTURING SECTOR - FOOD PROCESSING INDUSTRIES

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Adapting to Changes in Water Availability - Industrial & Commercial Sectors

Lecture 3.2: Manufacturing Sector - Food Processing Industries

Educational Aim

This lecture overviews ways in which food processors can reduce the amount of water consumed in plant processing and cleaning, as well as in auxiliary amenities such as washrooms, cafeterias and gardens. It discusses future trends and possible opportunities in water reuse and recycling for significant water consuming food processors in Australia including the meat industry, chicken and poultry, dairy, and fruit and vegetables industries, featuring examples of significant water saving achievements.[1]

Learning Points

1. Within the manufacturing sector, food processing tends to be a significant water user. In Australia, the food, beverage and tobacco industries are collectively the largest water users in the manufacturing sector, using 39 per cent (215 GL) of the total water consumption by industry. Water is used for a variety of operations including general processing (such as washing raw ingredients, rinsing, blanching, cooling, cooking, conveying and as an ingredient)[2], operating specific utilities (such as boilers, cooling towers and pumps), cleaning equipment, and for auxiliary amenities such as toilet flushing and washing facilities. While each food processing industry will use water in different ways, and at different stages of their processes, there are many common ways in which all food processers can save water.
2. Due to the drought in Australia and rising water prices, Australia's food processing industries have been actively working to find ways to reduce water use. The business case for saving water becomes even more apparent when the full cost of water is taken into account including: the purchase of potable water; treatment of water; heating or cooling of water; treating wastewater; disposal of wastewater to the sewers; pumping and maintenance; and capital depreciation of related infrastructure. While the typical purchase cost of water in Australia is around AU$1.13 per kilolitre (kL), when factoring in these additional costs it is actually AU$2.33 per kL for water at ambient temperature, and AU$5.13 per kL for water which has been heated to 80°C.[3]
3. Hence, saving water can clearly lead to significant cost savings, as found by a number of companies over the last decade. For example, a 2001 survey by the 'Australian Food and Grocery Council' found that about half of the companies surveyed had reduced their water

[1] This lecture focuses on opportunities for water savings within current industry practices in the food processing sector. In highlighting water saving opportunities within these industries, the Authors do not endorse the food processing methods described.
[2] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p55, http://ww2.gpem.uq.edu.au/CleanProd/food_project/Food%20Manual.pdf, accessed 16 November 2007.
[3] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p 56.

consumption during a five-year period in the late 1990s, with more than half of these companies achieving reductions of over 10 per cent, and two-thirds expecting further reductions.[4] Similarly food processes in the USA and Europe have been able to achieve water savings through investing in the latest process methods and technologies. For example, according to The Pacific Institute, '*Oberti Olives olive processing plant in Madera, California processes about 128 tonnes of olives per day, washing, curing, storing and packaging. Installation of best practice membrane filtration system to enable water reuse resulted in a 91 per cent in freshwater usage saving over 3.5 ML per day*'.[5]

The following learning points outline some of the key water saving strategies for the food processing sector:

4. *Stop Leakages:* Leaking equipment, such as pumps, taps, valves and hoses can waste large amounts of water over time. It is essential to identify leaks quickly and repair them to reduce water losses and save money, and the possibility of further damage to equipment.

5. *Use Efficient Spray Nozzles:* Food processing often requires the use of water spray nozzles, to clean containers and process equipment, lubricate processes and conveyor belts or to cool equipment or products during processing.[6] Improvements in spray and jet technologies have created opportunities for significant water saving in this area. For example, Schweppes Cottee's in New South Wales replaced the nozzles on their cordial container wash systems with water efficient models, and now save just under 8,000kL of water each year, with a payback period on the investment of 10 weeks.[7]

6. Optimise Flow Pressure: Often equipment is operating at a water pressure or flow rate that is higher than is necessary. By trialling performance it is often possible to determine the optimal profile for water pressure and flow rate for the equipment. Alternatively, checking the equipment manufacturers' specifications might reveal that a lower flow rate can be used with the equipment without impacting on performance. Installing flow regulators can help maintain a constant (and optimum) flow rate once it has been determined. In the UK, a fish processing plant for GW Latus installed flow regulators on the filleting benches and found that the flow rate was reduced from a variable 13 litres per minute to a consistent 8L/min, saving an estimated AUD$7,950 each year in water costs.[8]

7. Use Process Control Devices: There is now a large range of process instrumentation options available to help operators optimise their product yield and minimise wasted water and product by better controlling equipment operation. In the UK, one brewery was losing beer worth over AUD$2.3 million each year in its wastewater, and it found that most of the loss came from a single part of the process that could be easily and cheaply rectified using a control devise, and saved an estimated AUD$1.8 million each year in recovered beer, and in reduced wastewater charges.[9] Other process control devices can be used to closely monitor the water pressure in particular process and ensure that it is matched to the requirement, or to assess the requirement

[4] Australian Food and Grocery Council (AFGC) (2001) 'Cleaning up waste water - Goodman Fielder', *Environmental Report 2001*, cited in Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p55.

[5] The Pacific Institute (1999) *Sustainable Use of Water California Success Stories*, The Pacific Institute, Australia.

[6] Queensland Government (2008) '*Water Efficient Processing – W2: Eco-efficiency resources for the food processing industry – Reducing demand for water in processing*', Queensland Government.

[7] North Carolina Division of Pollution Prevention and Environmental Assistance (undated) 'Cleaner Production Demonstration Project at Schweppes Cottee's', p2pays.org/ref/04/03356.htm, accessed 12 September 2009.

[8] Environmental Technology Best Practice Programme (1999) 'Reducing Water and Effluent Costs in Fish Processing', ETBPP GC187, Crown, p19.

[9] Envirowise (1999) 'Low Cost Process Control in Food and Drink Industry', ETBPP GC220.

for cleaning a filter or system to minimise unnecessary cleaning, saving both water and cleaning chemicals.[10]

8. Reduce Water Losses in Boilers: Some manufacturing processes use boilers to generate steam, and water is often lost as steam escapes the system. However this can be minimized by using steam traps which collect the condensed water and return it into the boiler. The loss of steam from the system can also result in water quality issues. When water is converted into steam it can leave minerals and dissolved solids behind in the boiler, that if not removed can accumulate on the inside of the boiler and pipes, forming what is commonly referred to as 'scale'. Scale can significantly impair the efficiency of the system by interfering with the heat flow from the boiler to the water and can even lead to system failure. Hence when steam is lost rather than condensed and returned to the boiler, new water needs to be brought it, with new dissolved solids. To minimise this, a portion of the boiler water is periodically removed (similar to cooling towers that need to be 'bled off') and is replaced with fresh make up water, a process which can consume considerable amounts of water. The amount of makeup water can be significantly reduced by acidifying the water, filtering and returning bled out water, and using magnetic pulse technology and scale inhibitors.[11]

9. Change Processes to Reduce Water Requirements: There are a number of opportunities in many food processing operations to reduce water demand without affecting performance.. This can be done by modifying existing process operations, or finding alternative ways of achieving the same outcome using a more water-efficient method. For example, in some processing plants vegetables, or other items, are conveyed from one area to another by using flowing water. Hence, by switching to a mechanical or pneumatic (compressed air) method the use of water can be eliminated. A process change may also be the level of processing required, such as steaming vegetables rather than blanching them, using less water

10. Reduce Water Used in Cleaning: Most food processing plants use a significant portion of their total water consumption for cleaning. This can typically range from 10 per cent for a 'dry' process such as nut processing, to over 40 per cent for a meat processor or dairy. There are many ways in which the amount of water used for cleaning can be reduced, such as:[12]

    - Dry Cleaning: Removing as much product as possible from the plant and cleaning equipment using a dry technique before a final wash down, reducing water use and improving the quality of wastewater.

    - High-pressure Cleaning Systems: A high pressure hose can use up to 60 per cent less water than a hose attached to the water mains.

    - Trigger-Operated Controls for Hoses: Installing a trigger (AUD$20 to $100) on hoses allowing them to be turned on and off from the hose end rather than the tap. A hose left running for one hour a day can waste in the range of 470-940kL in a year, costing AUD$1,090-$2,180.

    - Design and Selection of Processing Equipment: Designing equipment with fewer parts and streamlined design making it easier to clean, and reducing water and chemicals use.

[10] Envirowise (1999) 'Low Cost Process Control in Food and Drink Industry', ETBPP GC220.
[11] Alliance for Water Efficiency (undated) 'Manufacturing Introduction', www.allianceforwaterefficiency.org/Manufacturing_Introduction.aspx, accessed 18 August 2009.
[12] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, pp68-74.

- Scheduling Product Changeovers: The amount of cleaning water can be reduced by modifying production to minimise the number of product and ingredient changes, and scheduling similar products to be processed sequentially.
- Automatic Container Washers: Automatic container washers use up to 95 per cent less water than pressure cleaners, carrying out various functions such as soaking, pre-washing, washing, rinsing, disinfecting and sometimes also drying.
- CIP (Clean in Place) Systems: CIP systems can be optimised using in-line sensors to detect when the rinse water is clean and the cycle can stop. In some cases final rinse water can be collected and used for pre-rinse. Caustic recovery can also deliver additional savings.

11. Food health standards stipulate that water can not be reused where it will come into contact with edible products, however most food processors use water for such a variety of purposes that there are many ways in which wastewater can be safely and economically reused. Some waste streams can be either used directly, or may require some limited treatment prior to reuse. For example, the Fosters Brewery at Yatala in Queensland has been able to drastically reduce their water consumption by using recycled water for all uses besides those which come into contact with the beer itself.[13]

Brief Background Reading

In 2004-2005, the Australian food, beverage and tobacco industry was the largest water user of Australia's manufacturing industry, using 39 per cent (215 GL) of the total water consumption by industry.[14] Given the significant water consumption of food processors in Australia including the meat industry, chicken and poultry, dairy, and fruit and vegetables, the following parts highlight some of the key water saving opportunities specific to these industries, with thanks to information provided by the UNEP Cleaner Production Working Group based at the University of Queensland which has undertaken extensive research on the food and processing sector. Table 3.2.1 also summarises some examples of water saving opportunities in these industries.

Table 3.2.1 *Examples of Water Savings in Key Food Processing Industries*

Case Study	Key Water Savings Achieved in Various Australian Processing Plants
Meat and Fish Processing	
SA Meat Corporation, South Australia	SA Meat Corporation (SAMCOR) in South Australia invested AUD$10,000 in the installation of a limit switch and solenoid on the viscera table wash spray system that turns off the water supply when the dressing line stops and during operator breaks, in addition to installing finer nozzles. This initiative saves 90 kL per day of hot water, AUD$19,800 per year in water, AUD$2,250 per year in wastewater treatment and AUD$22,000 per year in energy.[15]
Port Lincoln Tuna Processors, South Australia	Port Lincoln Tuna Processors made strong investments in water savings, and found that the cost of water usage per tonne of processed fish has now reduced by over 50%.[16]

[13] The Fosters Group (2007) *Yatala Brewery: Water Usage Facts*, The Fosters Group, www.fosters.com.au/about/docs/Yatala_Water_Fact_Sheet.pdf, accessed 19 June 2009.
[14] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p 56.
[15] Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p 32.
[16] South Australia EPA (2001) *Cleaner Production case study- Port Lincoln Tuna Processors,* Australia at http://www.epa.sa.gov.au/xstd_files/Industry/Report/cppltp.pdf accessed 11 April 2010

Case Study	Key Water Savings Achieved in Various Australian Processing Plants
Chicken and Poultry Processing	
Red Lea Chickens, New South Wales	Following a 2002 water audit of its Blacktown plant, which showed the plant used large volumes of water in every process step as well as for wash downs and refrigeration, Red Lea Chickens invested AUD$3 million into water saving initiatives that also reduce energy costs and increase reliability. Air-cooled condensers save up to 5 ML per year as well as saving on maintenance costs since, unlike evaporative condensers, they do not require regular inspections nor water treatment. A further 3 ML of water per year has been saved by the installation of a number of heat recovery initiatives that reduce the demand for cooling for heat rejection.[17]
Joel's Poultry Processers, South Australia	Joel's Poultry Processers in South Australia reduced their water consumption by 55%, with a payback period on the investment of only 3½ months.[18]
Dairy Processing	
National Foods, Penrith, New South Wales	National Foods, at its Penrith plant, reduced its ratio of water intake to raw milk intake from 1.75 L/L to 0.8 L/L over an 18 month period in the early 2000s, when it was producing over 187 ML of milk per year.[19] After fixing leaks, educating staff and undertaking a water audit the company invested AUD$86,000 to reduce its water use by 110 kL per day (22% to the plant's total water use) and saved AUD$104,000 per year. This included recycling of crate washing water, recycling pasteuriser water, efficient truck and tanker washing, stormwater collection, redesigning the bottle conveyer wash sprayers, improving monitoring and maintenance and introducing electrically operated valves on production line water nozzles,[20] and reducing water losses in cooling towers.[21]
Fruit & Vegetable Processing	
Harvest Freshcuts, Queensland	Harvest Freshcuts, who produce salads and vegetable products for major supermarket retailers, invested in water efficiency to reduce their consumption by 40%. This is now saving them an estimated AUD$22,300 each year in reduced potable water purchase charges and disposal costs alone.[22]
Irymple Citrus Products, Victoria	Irymple Citrus Products in Victoria invested in various initiatives that capture condensate and recycle it in its boilers, use counter-current rinsing, and capture and recycle water from sprays. These initiatives reduced the plant's water use by 30%.[23]
Golden Circle, Queensland	At Golden Circle's sugar plant, efficiency measures are now saving them up to AUD$20,000 each year. By 2005, they had reduced their water consumption by 15% compared with 2000 levels and have reduced their water intensity from 6.47 kL per tonne of production to 6.05 kL/tonne.[24] In their hot-filling bottled fruit juice process, a AUD$400 investment in the installation of a pipe between two stages of a cooler that was overflowing subsequently prevented about 6,660 kL of water per year from overflowing, equating to AUD$34,000 in water supply, treatment and discharge costs.[25]
Goodman Fielder, New South Wales	Goodman Fielder, one of Australia's largest food manufacturers, reduced their water consumption by over 20% and found themselves saving around AUD$60,000 each year as a result.[26]

Source: Compiled by TNEP, with sources noted.

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[17] Sydney Water (2006) 'Red Lea reaps returns on $3 million investment', *The Conserver*, no 10, pp 10-11.
[18] SA EPA (1998) *Cleaner Production case Study – Joe's Poultry,* Environmental Protection Agency - South Australia.
[19] Sydney Water (2004) 'No Spilt Milk… or Water: Timely management delivers big cost reductions', *The Conserver*, no 4, pp 7-8; Prasad, P., Pagan, R., Kauter, M., Price, N. and Crittenden, P. (2004) '*Eco-Efficiency for the Dairy Processing Industry*', Dairy Australia. p 23, 32.
[20] Sydney Water (2004) 'No Spilt Milk… or Water: Timely management delivers big cost reductions', *The Conserver*, no4, pp7-8.
[21] Australia Industry Group (AIG) (undated) *National Foods Cooling Tower Minimisation Study*, AIG, http://pdf.aigroup.asn.au/environment/NATIONAL_FOODS_case_study.pdf, accessed 1 October 2009
[22] Qld EPA (2003) *Ecoefficiency – Cutting costs in the food processing industry - Harvest FreshCuts,* Environmental Protection Agency – Queensland, Australia,.
[23] Envirowise (2001) cited in Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p 67.
[24] Australian Food and Grocery Council (2005) 'Environment Report 2005, Australian Food and Grocery Council', Barton, ACT, Australia, p14.
[25] UNEP Working Group for Cleaner Production (2003), *Eco-efficiency in the Queensland Food Processing Industry Project: Golden Circle,* cited in Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', The UNEP Working Group for Cleaner Production in the Food Industry and the Australian Industry Group, p 64.
[26] Sydney Water (2005) 'Food for Thought', *The Conserver,* Issue 5, pp5-6.

Water Productivity in Meat Processing

The report, 'Eco-Efficiency Manual for Meat Processing', by The University of Queensland's 'UNEP Working Group for Cleaner Production in the Food Industry' discusses the major areas of water use and several water saving opportunities, including cost/savings analyses.[27] A breakdown of the water use in a typical meat processing plant is shown in Figure 3.2.1, where 50 per cent water use is for maintaining basic plant operations (depending on operator practices), while use of the remaining 50 per cent varies, depending on the rate of production.[28] The largest area of water use in the plant is the slaughter and evisceration (i.e. disembowelment) area, using 40-50 per cent of the total. Food safety regulations require 30-40 per cent of water used to be either hot (82ºC) or warm (43ºC).

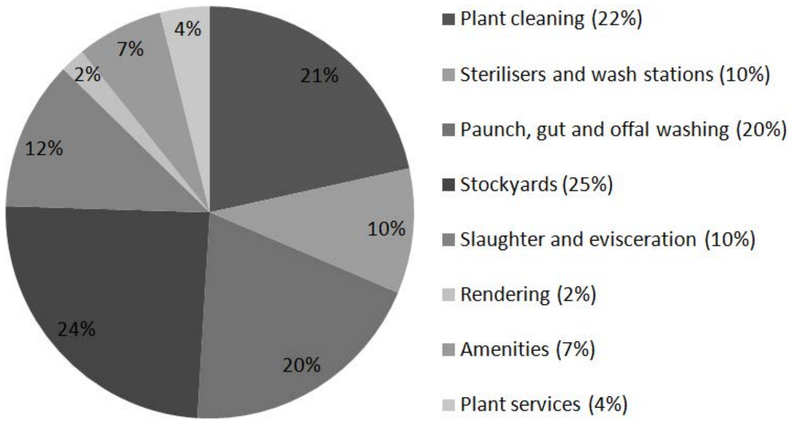


Figure 3.2.1. Breakdown of the water use in a typical meat processing plant

Source: Based on data from the Meat and Livestock Association[29]

Key opportunities for saving water that are highlighted in the report include:

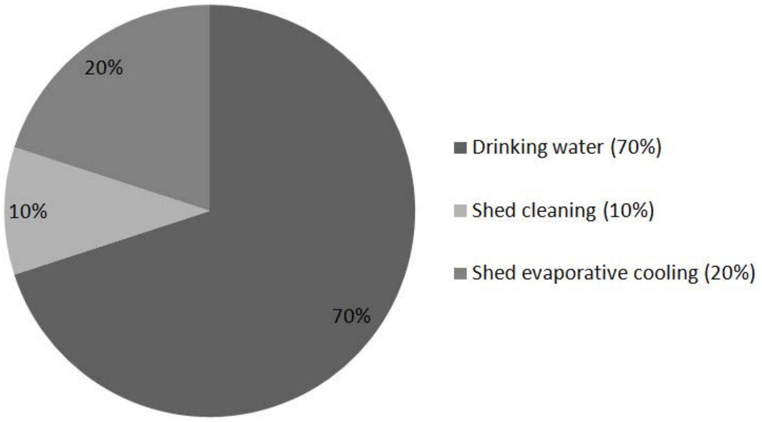
- *Washing Cattle:*[30] Typically, when large wash pens are not full, cattle crowd into a corner and only about 50-75 per cent of the floor-mounted and overhead jets are effective. Subdividing pens into several zones or using long, narrow pens saves water as unused jets can be turned off. Modifying a pen may cost AUD$5000-$10,000 and assuming 50 per cent of the jets are turned off on average, can achieve around 35kL daily and AUD$14,000 per year.
- *Yard Cleaning:*[31] Removing most of the solid manure from yards prior to washing with water (i.e. 'dry cleaning') can reduce water use by about 20-30 per cent, enabling the collection of dry manure for sale or use in a digester to produce energy. Effective dry cleaning relies on good operator training and practices, which may be enhanced by tools such as industrial vacuum cleaners. In a typical plant, dry cleaning has a very low cost and may bring water savings of about 25kL of per day and AUD$10,000 per year, as well as savings of about AUD$3,000 per year in treatment costs.

[27] Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, pp21-55.
[28] Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p22.
[29] Meat and Livestock Australia (MLA) (1996) *Trends and future regulatory issues concerning packaging material used in the Australian meat industry*, M.713, Sydney, cited in Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p21.
[30] Wescombe, G. (1994) *Cattle Cleaning - Brisbane*, *Australian Meat Technology,* Meat Research Report No. 3/94, http://www.meatupdate.csiro.au/ (1994) cited in Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p28.
[31] March Consulting Group (1998) and Walford et al (1994) cited in Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p 29.

- *Washing processing tables:*[32] Some modern processing tables have wash sprays that are on intermittently, while older tables usually have continuously running sprays that can be retrofitted with sensors and controls, reducing water use by more than 50 per cent. In a typical plant, intermittent spraying may cost about AUD$5,000-$7,000 with water savings of about AU$15,500 per year, as well as savings of about AU$300-$10,000 per year in water heating.
- *Washing equipment:*[33] Single-skinned sterilisers use a continuous flow of hot water to wash knives and instruments used in meat production, with required water flows depending on the heat loss rate. Double-skinned sterilisers have an insulating air gap that reduces heat loss, but water flow rates are not necessarily reduced. This can be addressed using water jacket sterilisers which have a hot water jacket to maintain water temperature, and where the jacket water is continually returned to the boiler for reheating. The steriliser water is also only disposed of when water is relatively dirty, reducing water use by about 70 per cent compared to the other sterilisers. Water jacket sterilisers cost around AUD$10,000-$20,000 with water savings of about 42kL per day and AUD$16,500, as well as savings of about AUD$900-$28,000 per year in water heating.
- *Washing casings:* In some plants, water for washing casings is left running continuously even though washing occurs for only about 60 per cent of the time. A timer switch can be installed to permit water to run in synchronisation with the washing requirements, which can reduce water use by 40 per cent, and subsequently reduce the amount of wastewater treatment. In a typical plant, intermittent washing may cost about AUD$1,000 and may bring water savings about 12kL of per day and AUD$4,600 per year.

Water Productivity in Chicken and Poultry Processing

An average Australian poultry farm produces 650,000 birds per year and consumes up to about 5,500 kL of water per year, which costs about AU$5,000.[34] A breakdown of the water use in a typical chicken and poultry processing plant is shown in Figure 3.2.2, with the majority used in drinking water.



[32] Walford, J., Lovatt, S., Willix, J. (1994) *Measurement and modelling of hot and warm water usage in meat plants*, Hamilton, New Zealand, Meat Industry Research Institute of New Zealand, cited in Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p31.
[33] Walford, J., Lovatt, S., Willix, J. (1994) *Measurement and modelling of hot and warm water usage in meat plants*, Hamilton, New Zealand, Meat Industry Research Institute of New Zealand, cited in Pagan, R., Renouf, M. and Prasad, P. (2002) 'Eco-Efficiency Manual for Meat Processing', Meat and Livestock Australia, p 34.
[34] Queensland Chicken Growers Association (undated) 'Factsheet – Eco-efficiency in the Poultry Industry: Water Use in Poultry Sheds', Queensland Chicken Growers Association, South Brisbane, Queensland, http://ww2.gpem.uq.edu.au/CleanProd/poultry/water%20use.pdf, accessed 20 September 2009.

Figure 3.2.2. Breakdown of the water use in a typical chicken and poultry processing plant

Source: Based on data from the Queensland Chicken Growers Association[35]

Water use can be reduced in each of these areas as highlighted below:[36]

- *Suppling drinking water: '*Nipple drinkers' are the most efficient type of equipment for supplying water to chickens, incorporating outlets with small projections that deliver droplets of water as the birds drink. Some models also have small collection trays under the nipples to prevent bedding material from getting wet. Water losses due to leaking nozzles and pipe connections can be prevented by maintenance and servicing.
- *Cooling systems:* Excess water run-off from evaporative cooling systems and overhead foggers used in bird sheds can be reduced by installing thermostats and controllers to control the number of nozzles in operation at any one time; and by recycling the water used using a sump, filter and recycling pump. In a typical shed, recycling the water is the simpler and more effective option and, once implemented, may affect the return on investment of installing control instruments.
- *Use high pressure, low volume water cleaners*: Both high pressure, low volume water cleaners and low pressure, high volume cleaners have water flow rated of about 15-20 litres per minute, depending on the size and discharge pressure of the cleaner. However, high pressure, low volume water cleaners provide a more forceful jet and can reduce cleaning time by about 50 per cent, hence reducing water use by about 50 per cent.

Water Productivity in Dairy Processing

The Australian dairy industry uses about 30 GL of water per year for processing milk with a breakdown shown in Figure 3.2.3.[37] Of the milk processed around 20 per cent becomes milk,[38] with more than two-thirds dewatered to produce cheese (36%), butter (28%) and milk powder (12%).[39]

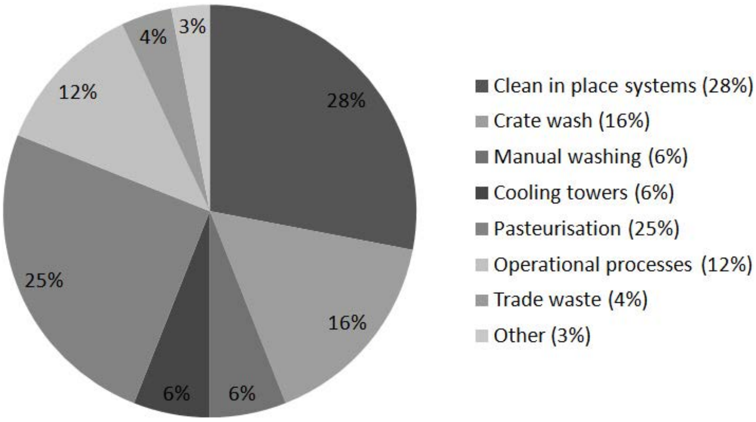


Figure 3.2.3. Breakdown of the water use in a typical plant that produces market milk

Source: Based on data from The University of Queensland UNEP Working Group for Cleaner Production in the Food Industry and Sustainable Business[40]

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[35] Queensland Chicken Growers Association (undated) 'Factsheet – Eco-efficiency in the Poultry Industry: Water Use in Poultry Sheds', Queensland Chicken Growers Association, South Brisbane, Queensland.

[36] Queensland Chicken Growers Association (undated) 'Factsheet – Eco-efficiency in the Poultry Industry: Water Use in Poultry Sheds', Queensland Chicken Growers Association, South Brisbane, Queensland.

[37] Prasad, P., Pagan, R., Kauter, M., Price, N. and Crittenden, P. (2004) 'Eco-Efficiency for the Dairy Processing Industry', Dairy Australia. p19.

[38] Dairy Australia (2007) *Dairy 2007 Situation and Outlook*, Dairy Australia.

[39] Dairy Australia (2007) *Dairy 2007 Situation and Outlook*. Dairy Australia

Hence considering that only 20 per cent of milk, from the farm, is sold as milk, and as cows milk is 95 per cent water, dewatering a large proportion of milk before cooling it, storing it and transporting it to processing facilities can not only significantly reduce energy consumption, but provide a source of water for use on the farm. [41] As the University of Queensland UNEP Working Group for Cleaner Production in the Food Industry's report, '*Eco-Efficiency Manual for the Dairy Processing Industry*', argues, the water from milk is suitable for meeting more than 95 per cent of the plant's total water demand. This includes boiler and cooling tower feed water, in 'clean in place' systems (which circulate cleaning and rinsing fluids through the milking machine without disassembling it), as cheese curd wash water, in dryer wet-scrubbers, for indirect heating (via heat exchange) and as pump seal water. As the amount of condensate available depends on the amount of powdered product produced, supply is lower during off-peak times. Condensate treatment is usually by reverse osmosis, a type of filtration process that removes trace elements and product carryover, and which removes 90-95 per cent of the biological oxygen demand (BOD) from the condensate.[42] However, the cost of treating condensate is currently higher than purchasing mains water[43] and water recovered from some processes (such as whey permeates) may not be suitable in cheese factories due to the risk of bacteriophage reducing fermentation rates, lowering the quality of cheese produced.[44]

The report outlines further opportunities such as reducing water use in crate washers through recirculation and additional maintenance to prevent water losses due to leaks. Further a more efficient clean may be achieved (while still meeting hygiene standards) by manipulating the washer speed and length of cleaning cycles. Furthermore equipment such as vacuum pumps, centrifugal pumps and homogenisers require water for sealing and cooling. This water is often used only once before being disposed but can be recovered and reused it elsewhere in the plant. Some equipment, such as pumps, may have dry mechanical seals, which eliminate the demand for sealing water, but care should be taken with pumping pasteurised products because the product is difficult to clean if it goes beyond the seal.

Water Productivity in Fruit and Vegetable Processing

The fruit and vegetable processing industry includes manufacturers of bottled and canned produce, sauces, concentrates and dried vegetable and fruit products.[45] A breakdown of the water use in a typical vegetable and fruit processing plant is shown in Figure 3.2.5.

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[40]Prasad, P., Pagan, R., Kauter, M., Price, N. and Crittenden, P. (2004) 'Eco-Efficiency for the Dairy Processing Industry', Dairy Australia. p20.
[41] MacMillan, G. (2009) Personal communications with Glenn MacMillan, 10 March 2009.
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[45] Australian Industry Group (undated) 'Water Saving Factsheet: Processed Fruit and Vegetables Industry', Australian Industry Group, Australia, pdf.aigroup.asn.au/environment/7082_WPA_fact_sheet_FRUIT.pdf, accessed 15 September.

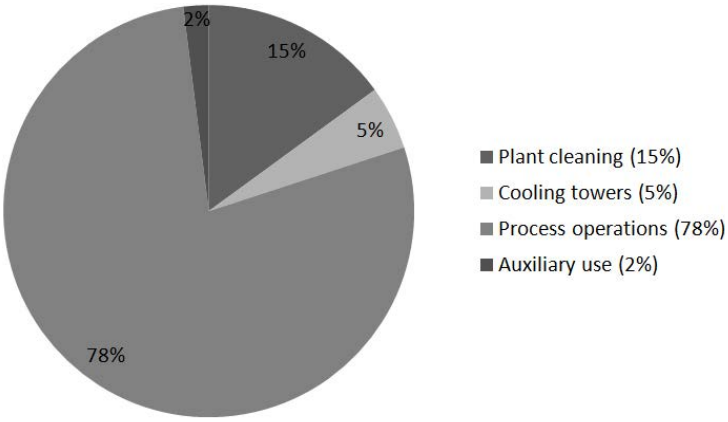

Figure 3.2.5. Breakdown of the water use in a typical vegetable and fruit processing plant

Source: Based on data from the University of Queensland UNEP Working Group for Cleaner Production in the Food Industry[46]

Water saving opportunities in 'process operations', the largest segment of water use, include:[47]

- *Use mechanical or pneumatic systems to transport products around the plant*: Some vegetable processors use water to transport vegetable products and bottles around the plant. Alternatively, these products can be conveyed using mechanical or pneumatic (compressed air) systems.
- *Use steam for blanching*: Some vegetable processors blanch vegetables in large vats of boiling water. Alternatively, steam, which can be sources from water used in other processes, may be suitable and would reduce both water and energy use.
- *Use sprays or air thaw products and radio-frequency waves to temper products*: Some processors thaw or temper (partially thaw) vegetables and fruits in open tubs of water, a process that uses a large amount of water and produces high-BOD wastewater. Alternatively, vegetables and fruits can be thawed with less water by using sprays, vacuum thawing, air blasting or still air; and can be tempered by radio-frequency tempering. This technology can reduce the use of water, energy and space, while tempering products in their packaging with uniform temperature distribution. Radio-frequency tempering is best suited for heating frozen blocks vegetables and fruits from -20°C to about 0°C.[48] There are food safety considerations when thawing meat and fish, but these alternative methods are available to save water.

[46] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p55.
[47] Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, pp66-67.
[48] Sairem (2003) 'Microwave and radio frequency: application food', cited in Pagan, R., Prasad, P., Price, N. and Kemp, E. (2004) 'Eco-efficiency Toolkit for the Queensland Food Processing Industry', Australia Industry Group, p67.

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