FUTUREDAIRY **information sheet**

Effluent management

for automatic milking systems

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The overall aim of an effective dairy effluent system is *'to return dairy effluent to the land in a controlled, sustainable and cost effective manner'*.

The way cows are milked (automatically or conventionally), does not change the fact that effluent will be collected on concrete areas of the dairy and will need to be sent to a storage and management system. Responsible effluent management is required for compliance with local council and state (EPA) regulations.

The average 500 kg cow excretes 50 kg of dung each day. The amount that is excreted at the dairy is generally proportional to the amount of time the cow spends there. So a cow that spends on average three hours per day at the dairy (2 x 1.5 hours) is spending 12.5% of each day at the dairy and is expected to excrete 12.5% of faeces in the dairy (6.25 kg). There is no reason to expect that this principle would be any different in an automatic milking system.

A 200-cow conventional dairy farm produces on average around 3-5 Mega Litres (ML) of effluent per year depending on water usage.

Effluent is a useful source of nutrients and water.

A storage system – whether single or a two pond effluent system – allows control over the amount of effluent spread and the timing of that spreading. It also allows spreading to meet plant requirements and to avoid runoff and leaching. Other benefits are the ability to effectively maximise the value of the stored nutrients for irrigation of crops and pasture and the option to recycle for yard wash.

Effluent regulations

In Victoria, dairy effluent is legislated under the State Environment Protection Act 1970 (Waters of Victoria policy 1988) and states: "All dairy effluent from milking sheds shall be disposed of by land irrigation and avoid any pollution to surface waters or ground water". This means ALL dairy effluent whether dryland or irrigation must be contained on the property and managed accordingly.

All states of Australia have similar acts pertaining to dairy effluent, some are enforced by state EPA's others by local councils. Refer to websites listed at the end of this document.

Effluent and automatic milking

In an automatic milking system (AMS), cows move around the farm system in a voluntary and distributed way; that is, they bring themselves for milking and take themselves back to the paddock. In a conventional milking system, milking occurs in two condensed periods of the day. In contrast, an automatic milking system involves small numbers of cows being milked at most times of the day and night. The milking units are in operation almost 24 hours a day.

Because cows go to the dairy at all times of the day, the holding yard of an automatic milking system does not need to be large enough to hold the whole herd. It is generally scaled to hold about 30% of the herd.

A smaller holding yard does not necessarily result in less solid effluent. The whole herd will still move through the holding yard within each 24 hour period. This creates the potential for a similar volume of effluent to be deposited on a smaller yard.

To date there is no evidence that AMS dairies collect any more or less solid effluent even though it could be reasonable to expect that reduced stress on the herd at the dairy (through reduced herding) could result in a reduction in effluent, provided it is not counteracted by increased waiting times at the dairy yard.

AMS effluent load

The amount of solid effluent captured on concrete areas of the dairy and surrounds depends on the average hours per day that each cow spends in that area. This is affected by milking frequency, average waiting time and whether there is a feeding area at the dairy.

Milking frequency

Milking frequency refers to the number of times a day the 'herd' is milked. In an automatic milking system some managers plan for cows to be milked more than twice a day (especially for cows in early lactation) to encourage higher levels of milk production.

If the milking frequency is more than twice a day, then the cows will spend more time in the effluent collection area.

Average waiting time

The average waiting time depends on:

- Ratio of cows to robots.
- Motivation level of the cows to move through the dairy.
- Management of the system and its impacts on distribution of cow traffic throughout a 24-hour period.

If large groups of cows move to the dairy at the same time, then the average waiting time will be much more than in a management system that results in a more steady stream of cows to the dairy across the day and night.

Feeding area

If the dairy is composed of a waiting yard, milking stations and a drafting pen then the time spent at the dairy is influenced mostly by milking frequency and waiting time.

If there is also a post-milking area with individual cow feed stations and/or a feedpad then the amount of time the cows spend at the feeding area will affect the effluent load. The rate of feeding will affect the time spent at the feeding area, and this is likely to change throughout the year.

With AMS there are almost always cows at the dairy which results in the yard being soiled most of the time. You will need to develop a system that works under these conditions. Yard washing at most automatic milking systems is done twice a day. Here are some tips:

- Easily cleanable surfaces are essential.
- A water-blaster/gerni will become your best friend.
- Tipper drums or automatic flood washing keep the manure wet and from building up during periods between yard washing.

Water use in an AMS

To date there is no evidence that AMS dairies use more or less water than their conventional counterparts. Water use includes plate coolers (if installed), robot plant washing, shed and yard washing. On average, a 200-cow conventional dairy farm uses around 10,000 litres of water per day at the dairy shed. On average 70% of water used at the dairy is for yard wash.

Dairy effluent re-use

A number of research projects conducted in south west Victoria examined how dairy effluent and sludge could be safely and effectively re-used back on the farm as a nutrient source for forage production.

Most of this work was conducted on a two pond effluent treatment system. The work focused on the re-use of effluent from the second pond and the sludge that forms on the bottom of the first pond.

First pond sludge

The dry matter (or solids) content of first pond sludge is quite variable.

The nutrient content of first pond sludge is similar to second pond effluent but it contains much higher concentrations of nitrogen, phosphorus, calcium magnesium and potassium. Most of the nutrients in first pond sludge are in an organic form which is less readily accessible to the plant. For example, less than 5% of the nitrogen is in a form that is immediately available to the plant.

Our soil and climatic conditions are favourable for sludge breakdown and nutrient release. Sludge is an effective, long acting, slow release nutrient source that can be used as a partial replacement for chemical fertilisers on farm. The research in Western Victoria found plant growth responses were still occurring three years after sludge application.

First pond sludge can be applied directly to established pasture, or incorporated directly into the soil. Pasture and milk production responses pay for the cost of application within three to six months.

Sludge improves soil chemical health by raising pH, organic matter, carbon and nutrient holding capacity. It also increases the amount of available potassium and sulphur. Applying first pond sludge may increase soil salinity but the effect is short lived.

Sludge applications can raise herbage nitrate levels to potentially dangerous levels. Although it is a short term impact, it is important to take care with the first few grazings. A withholding period of three weeks is a good rule of thumb.

Applications of first pond sludge can adversely affect herbage mineral balance (e.g. DCAD, K/Ca+Mg ratio) for a number of months after application. Consider this when deciding the class of livestock to graze the paddock.

Second pond effluent

As a fertiliser, second pond effluent is unbalanced. It contains large amounts of nitrogen and potassium. A high proportion of the nitrogen is in a form that is readily available to plants. Second pond effluent contains low to moderate levels of phosphorus and good levels of calcium and magnesium. It is slightly alkaline so has a liming effect on the soil. Second pond effluent is not suitable as irrigation water. Think of it as a carrier of nutrients only. It can be saline but this should not be an issue if best management practices are followed. That is, second pond effluent should be applied at a rate suited to the agronomic requirements of the plant. This is best achieved by conducting annual testing of second pond effluent. If high electrical conductivity is present second pond effluent should not be applied to the same area annually; rotate the application around the farm.

Plant responses to second pond effluent application are quite variable. Forage crops give the best responses to second pond effluent applications. The response is usually short lived, with nitrogen being the main driver of the response. To get a good result, plants must be actively growing. Do not apply second pond effluent to seedlings as there is a risk of foliage burning. It is best applied to crops about six weeks after germination.

Applying second pond effluent can upset the mineral balance (DCAD) in herbage for a few months, so don't put springers or freshly calved cows in these paddocks.

Effluent is excellent for correcting soil potassium deficiencies (e.g. after hay cutting). Apply second pond effluent at a rate equivalent to agronomically sensible nitrogen applications.

Animal heath issues

Avoid applying effluent to areas where young stock graze. Implement Johnnes disease management practices.

Avoid applying effluent where cows are to be calved due to grass tetany and milk fever issues.

When applying to pasture, a withholding period of three weeks is a good rule of thumb.

Managing ponds

First or single pond (anaerobic)

A single pond – or the first pond in a two-pond system – is an anaerobic pond. Anaerobic means without oxygen. An anaerobic pond is deep enough to create an environment without oxygen where microbes break down organic matter.

In an anaerobic pond, bacteria break organic matter into gases and sludge. This provides some degree of treatment of effluent but it is not suitable for discharge into waterways. How well the bacteria work depends on the temperature, pH and salinity. When a pond is working well there is no smell; gas bubbles can be seen on the surface and solids can be seen bubbling to the surface.

The size of an anaerobic pond depends on the solids entering the pond, the time period before desludging and the temperature.

An anaerobic pond needs to be desludged every three to five years depending on its design. The desludging process involves agitating the pond to bring the solids back into suspension to raise accumulated salts. Left unchecked, accumulated salts will reduce anaerobic function.

The sludge component is where much of the nutrient wealth is stored.

Equipment needed is determined by the way an anaerobic pond is managed. It could involve a stirrer, pump, slurry tanker, excavator and muck spreader.

If the pond is going to be managed simply by pumping, then you'll need a pump that can handle solids. Prior to any form of pumping the sludge needs to be brought back into suspension. You'll need a stirrer and pump capable of handling the solids in suspension.

A slurry tanker has the ability to pump sludge that contains 5-10% solids. Stirring while the tanker is being filled is recommended to allow for even spread. If the pond is managed correctly and some of the liquid is pumped off first, a slurry tanker should only be required every three to five years. This method can be reasonably cost-effective if the cost is considered across the years in between.

When using an excavator and muck spreader, the sludge needs to be reasonably solid (greater than 20% solid) to be removed with a bucket. This can be achieved by pumping the liquid off the top first.

The removed solids can then be stored on an impervious layer to further dry or may be spread immediately. To spread immediately you'll need a muck spreader that can handle liquid. If the sludge is left to dry out a belt spreader will do the job. The drying pad must be situated so the runoff and leaching is caught and not allowed to enter any waterway.

Second pond

In a two-pond effluent system, the second pond acts as a storage pond. It does not aim to breakdown the solids. It stores green water after treatment from the first (anaerobic) pond until the green water is either irrigated to pasture or crops or recycled for yard wash.

The purpose of a storage pond is to hold effluent over the wetter months when it cannot be safely applied to pasture without the risk of runoff. The capacity of the second pond must allow for storage of green water for four to six months depending on climatic conditions. The length of the storage period is usually determined by soil conditions as effluent cannot be applied when the soil is waterlogged (due to the increased risk of nutrient runoff). Effluent must be pumped out regularly during the drier period when safe to do so. The pond should be empty (or near empty) prior to the start of the storage period over the wet months.

To reduce surface areas and therefore the amount of rain falling on the second pond, it should be 3-5 metres deep, depending on the soil profile and ground water levels.

Pond size

The size of a storage pond depends on water useage, rainfall, storage period and the engineering freeboard.

Water usage depends on the amount of water required to clean the shed, yard, vat, milking equipment and plate cooler water if it is not recycled.

Pond size will also depend on rainfall. Allow for the amount of rain falling on the yards, the shed roof (if not collected in storage tanks), the ponds themselves and any surrounding surface runoff that is not diverted.

The number of days that storage is required usually depends on the length of time rainfall is greater than evaporation in your region.

When determining your pond size allow extra volume to accommodate wave action on pond surface and to provide a safety margin for dairy shed water use variations.

Equipment

A variety of equipment can be used to empty a storage pond. The equipment varies in price and how much time is needed to maintain and run the system.

Irrigation pumps can be used, including PTO-driven and stationary (electric and fuel driven) pumps. The size and type of pump needed depends on the type of use, such as recycling for yard wash or irrigation to pasture and crops.

If you use an irrigator, the type that can be used will be determined by the way the first pond is managed. The pipe size (diameter and pressure rating) will be determined by the distance needed to pump and the type of irrigator.

Safety

Dairy effluent ponds have the potential to be extremely hazardous to children, farm operators, pets and livestock. Every effort should be made to make them safe.

Farm children and employees need to be made aware of the hazards of effluent ponds and particular attention needs to be paid to warning visiting children. Ponds should be fenced as soon as construction has been completed to minimise the risk to young children and stock. Appropriate signs warning of deep water or showing relevant hazard symbols are also warranted. Signs are available from safety equipment suppliers.

It is important to be very aware of safety when working around effluent ponds.

WorkSafe Victoria suggests that where practicable farmers, farm contactors and the designers of effluent ponds should try to minimise the need to use tractors near the edge of effluent ponds. Where this is not possible, safe systems of work should be adopted, including using barriers or chocks to prevent the tractor from moving backwards into the pond.

More information

Agnote: Dairy Effluent: Building and Operating a Safe System: www.dpi.vic.gov.au

Management of dairy effluent: 2008 Dairygains Victorian Guidelines:

http://www.epa.vic.gov.au/water/docs/2008-DairyGains-Victorian-Guidelines.pdf

State regulations:

http://www.dairyingfortomorrow.com.au/index.php?id=48

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About FutureDairy

FutureDairy aims to help Australia's dairy farmers manage the challenges they are likely to face during the next 20 years. The challenges are expected to be related to the availability and cost of land, water and labour; and the associated lifestyle issues.

Our activities are structured around two priority areas – Precision farming (including automatic milking and innovations) and Feedbase (forages and feeding). These are the areas where there are opportunities to address the challenges related to water, land and labour resources.

For Precision Farming we are investigating technologies with potential to improve farm productivity, efficiency, labour management or lifestyle. FutureDairy is pioneering the development of pasture-based farming systems that use robotic milking for larger herds. Our research is conducted at Australia's first automatic milking system (AMS) research farm, at the Elizabeth Macarthur Agricultural Institute at Camden. Since mid-2009 we have been testing a new concept automatic milking system designed specifically for Australian conditions, while continuing to further develop the farming system around the milk harvesting equipment.

Our Feedbase goal is to develop sustainable dairying systems for the future, with the intensification of home-grown feed to enable more efficient use of land, water and grain. Our trials are being conducted at the University of Sydney's Corstorphine dairy farm and Mayfarm. The investigation is complemented with modelling and component field research in areas of forage production and utilisation.

We are investigating a complementary forage system (CFS) that involves triple cropping on 35% of the farm area and growing pasture on the remaining 65%. Our target is to produce more than 25t DM/ha/yr over the whole farm area, in a sustainable way. The three crops include:

- a bulk crop (eg maize);
- a legume for nitrogen fixation (eg clover); and
- a forage to provide a pest/disease break and to improve soil aeration (eg a brassica).

FutureDairy is now in its second phase. During the first phase, we used existing technology for automatic milking to test the feasibility of robotic milking in a pasture based system. The promising results paved the way for testing a new prototype AAMS with a larger herd during phase 2.

In the first phase, our Feedbase studies tested the feasibility of a complementary forage rotation grown on a small area, both under research and commercial conditions. Phase 1 combined technical research with social research and extension research. During phase 2 we are drawing upon that learning experience to improve our linkages with major extension groups.

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