Chapter 13
Using Dairy Effluent

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13 Using Dairy Effluent

13.1 Introduction

Australian dairy farmers, industry and government agencies can now access a wealth of technical information that has been collated from around Australia and overseas with respect to the design and management of dairy effluent systems.

The Effluent and Manure Management Database for the Australian Dairy Industry is a source of reliable and scientifically-validated technical information on dairy effluent management that is adaptable to all dairying regions in Australia. The database is updated and maintained regularly, and outlines the principles for effective effluent management. It includes performance based design criteria for components of effluent containment and reuse systems, and appropriate management principles for optimal operation.

This database can be found on the Dairy Australia's Dairying for Tomorrow website (http://www.dairyingfortomorrow.com/index.php?id=48) and is recognised as a principal reference.

Key points:

- Dairy effluent is a natural fertiliser and soil conditioner and, if managed effectively, can enhance pasture growth and improve soil structure.
- Effluent can be utilised safely and effectively if it is applied to meet the agronomic needs of the crop or pasture intended for its reuse.

13.2 Legal requirements of dairy effluent management

Dairy effluent is considered a potential point source for pollution of waterways. Mismanagement has the potential to impact water quality resulting in degradation of environmental assets.

All Australian States and Territories have set minimum standards that all dairies, irrespective of size, must comply with. These standards include State and industry legislation, codes of practices, guidelines and planning provisions to prevent any adverse impact from dairy effluent.

It is important to note that the environment protection frameworks and associated policies across Australia place the onus of environment protection on those that manage the land and water resources.

The fundamental principles regarding the management of dairy effluent should ensure:

- All effluent from the dairy, feedpads, standoff areas, underpasses and tracks must be contained and reused (most commonly spread back on pastures and crop).
- Effluent must not enter surface waters (including billabongs, canals, springs, swamps, natural or artificial channels, lakes, lagoons, creeks and rivers).
- Runoff containing effluent must not leave the property boundary.
- Effluent must not enter ground waters either directly or through infiltration.
- Effluent must not contaminate land (that is, avoid nutrient overload).

- Offensive odours must not impact beyond property boundaries.

Farmers should also be aware that recent changes in various States have seen risks associated with effluent management being incorporated into Dairy Food-Safety Audits to ensure a more consistent approach.

13.3 Nutrients in manure; how much is there?

Understanding the characteristics and quantity of manure being generated by the farm's dairy herd is the logical starting point for developing management strategies to utilise the resource and ultimately achieve production gains.

As the nutrient concentration in effluent is dependent on a range of site specific factors and is therefore variable from farm to farm (see Section 13.3.4), it is often more useful to start by estimating the total amount of each nutrient that is captured by the effluent system. The mass of those nutrients recoverable from the effluent system (i.e. in the sludge or in the liquid effluent after taking losses into account), and subsequently how much of each is available for plant uptake, can then be estimated.

While monitoring 43 dairy farms located across Australia, the Accounting for Nutrients project determined that almost half a kilogram of nitrogen is excreted daily by each cow – see Table 13.1. That is about 7 times the amount of phosphorus excreted. Therefore, for an average herd size of 250 cows over a 300-day lactation, 32.4 and 4.6 tonnes of nitrogen (N) and phosphorus (P) respectively are excreted around a dairy farm.

Table 13.1 Daily nutrient excretion by lactating cows from Accounting for Nutrients project; 43 farms over 5 visits. *Source:* Gourley *et al.*, 2010.

NUTRIENT	MEAN g/cow/day	MEDIAN g/cow/day	MINIMUM g/cow/day	MAXIMUM g/cow/day	STD. ERROR OF THE MEAN
Nitrogen (N)	432.3	430.9	199.0	792	7.39
Phosphorus (P)	61.1	59.4	19.9	131.6	1.39
Potassium (K)	339.6	329.4	120.2	670.8	6.90
Sulphur (S)	43.8	42.1	18.5	101.7	0.88
Calcium (Ca)	91.3	88.2	9.6	210.3	2.69
Magnesium (Mg)	52.4	49.9	20.8	264.2	1.39

The volume and nature of excreta produced by the cow will vary depending on dry matter intake and composition of the diet, with higher production cows producing more excreta compared to lower producing animals.

It is important to be aware that dietary nutrient content in excess of requirements is excreted.

Excess dietary potassium is excreted in urine, as is excess protein in the form of urea. Excess phosphorus, however, is excreted in faeces, with only negligible amounts appearing in the urine. Because of the excretion of excess dietary nutrients, it is often suggested that manure management should focus at the front of the cow, rather than the back end. Similarly, adding excess salt in various feed additives to stimulate appetite can compound problems with salinity management when reapplying effluent, or in areas with heavy stock movement.

More detailed techniques for estimating manure and nutrient excretion can be found in the Effluent and Manure Management Database for the Australian Dairy Industry.

13.3.1 How much of that nutrient enters the effluent system?

Most existing guidelines assume that 10% to 15% of the daily manure output generated by the dairy herd is deposited onto surfaces from which effluent is collected – see Table 13.2. Although that is a reasonable estimation for the holding yard at the dairy, industry trends towards feeding increasing levels of supplements or mixed rations on a feedpad suggest this assumption needs to be adjusted on some farms to avoid underestimating the volume of manure and nutrients to be handled.

Surveys with farmers utilising permanent feedpad systems indicate it is common for these facilities to accommodate the herd for a significant majority of the day depending of seasonal climatic conditions and farm activities. Effluent system design and nutrient management practices on these farms will be significantly different to more typical, predominantly grazing-based farms.

Table 13.2 Amount of nutrients expected to be deposited in different areas for a typical (grazing-based) 250 cow farm over a 300 day lactation. *Source:* Gourley *et al*., 2010.

AREA OF FARM	% OF TIME SPENT IN THAT AREA	NITROGEN (N) (tonnes)	PHOSPHORUS (P) (tonnes)	POTASSIUM (K) (tonnes)
Paddocks	80%	25.4	3.7	20.4
Laneways	8%	2.5	0.4	2.0
Dairy shed & yards	12%	3.8	0.5	3.1

13.3.2 Nutrient movement within the pond system

The fate of nutrients entering the effluent system is an important consideration in dairy effluent management. An understanding of whether nutrients are partitioned with solids in the sludge or remain in the liquid effluent is the key to effective nutrient management and allows farmers to fine-tune fertiliser decisions.

This knowledge also allows farmers to allocate some monetary value to the nutrients recovered during desludging to credit against synthetic fertiliser inputs, thereby justifying the additional cost associated with their reuse further from the dairy.

Sedimentation of settleable solids is a key treatment process in ponds treating dairy shed effluent, partitioning both solid material and nutrients to the sludge in primary anaerobic ponds – see Figure 13.1. However, the fraction of manure nutrients partitioned to sludge is lower than for separated solids for two reasons. Firstly, organically bound N and P tend to be concentrated in fine, poorly settleable manure particles, and secondly, a fraction of the organic nutrients that do settle to the sludge are mineralised and released back into the effluent (*Fyfe 2013*).

Volatilisation of ammonia-N from the pond surface is responsible for some loss of nitrogen from the effluent system. While some past rules of thumb suggested this loss may be as high as 50% of total N, recent research on a commercial dairy in NSW suggests this loss may be less than 30% (*Fyfe 2013)*.

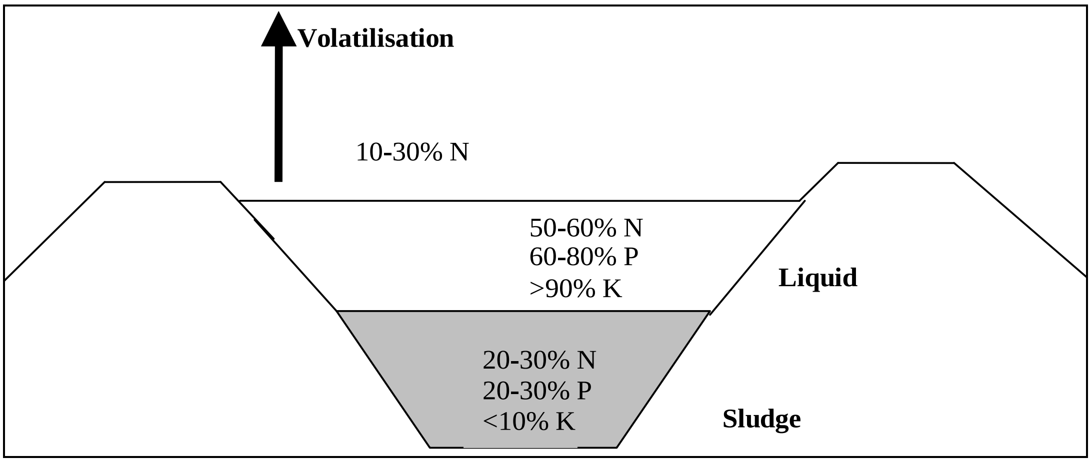

Figure 13.1 The proportions of nitrogen (N), phosphorus (P) and potassium (K) in the liquid (effluent) and sludge components of an anaerobic treatment pond and the proportion of N lost by ammonia volatilisation.

Potassium is highly soluble and non-reactive; therefore it is not prone to sedimentation or precipitation and is conserved through the effluent system and mostly recovered in the liquid effluent – see Table 13.3.

Table 13.3 Fate of nutrients in ponds, and the percentage of these nutrients available for plant uptake (shown in brackets). *Source:* Fyfe, 2013

POND COMPONENT	N (%)	P (%)	K (%)
Effluent	50-60 (70)	60-80	> 90 (100)
Sludge	20-30 (10)	20-30 (5)	< 10 (100)
Losses	10-30[a]	<10[b]	–

Note: [a] Volatilisation losses [b] Precipitation losses

13.3.3 Nutrient availability

Some of the nutrients in effluent will be in a form that is not immediately available for uptake by plants.

For example, the N contained in dairy ponds can be separated into five different pools as follows:

1. Nitrate (usually negligible amounts),
2. Exchangeable ammonium ions or other nitrogenous materials that can be readily converted to ammonium (which is plant-available),
3. Organic N compounds which are potentially available for mineralisation,
4. Microbial biomass, and
5. Essentially unavailable N which is resistant to microbial attack and the mineralisation process.

While 1 and 2 are available for plant uptake, mineralisation of 3 and 4 is necessary before plant uptake can occur, and this takes time.

Depending on the source, effluent will contain varying proportions of N in each of the above five pools. For example, sludge from the primary pond in an effluent system contains a large proportion of relatively stabilised organic material, with varying resistance to microbial attack and hence N release. Sludge only contains small amounts of immediately plant-available ammonium ions with much of the organic material in the sludge requiring mineralisation to release plant-available N over time. Thus primary pond sludge should be considered a slow-release nutrient source.

Second pond effluent however, typically has a very low solids content and has therefore quite different characteristics to that of sludge. It usually has a high ammonia N content (typically 50 to 90% of total N in southern Victorian surveys) and comparatively low amounts in an organic N form. As a high proportion of the total-N is in readily plant available forms, the application of second pond effluent will give quick plant responses. Research by Ward (2010) indicates that for first pond sludge, N uptake by plants over three years totalled 70 to 83% of N applied. Between 40 and 50% of the N applied was taken up in the first year, 10 to 30% in the second and 5 to 12% in the third. For the second pond effluent, responses to the ammonium-N applied were limited to within five to six months of application.

13.3.4 Typical nutrient concentrations in ponds

Before effluent or sludge is spread on the reuse area, it is best practice to decide what application rate (usually ML/Ha for effluent, or t/Ha for manure solids) is your target so that you apply the appropriate amount of nutrient – see Section 13.5.4. For this exercise, it is necessary to know the nutrient concentration (usually kg/ML or mg/kg) in the material to be applied.

A large number of dairy effluent ponds have been sampled across Victoria, and to a lesser extent, other dairy regions in Australia. To provide some indication of potential nutrient content in effluent ponds, the following tables (13.4, 13.5 and 13.6) present average constituent concentrations for effluents from primary, secondary and single ponds, respectively. *Note:* The amount of nutrients is expressed in milligrams per litre (mg L^{-1}) which is equivalent to kilograms per megalitre (kg/ML) of effluent. A megalitre is one million litres.

Table 13.4 Reported primary pond effluent characteristics (standard deviations in brackets).

		CROSS-SECTIONAL SAMPLING				**LONGITUDINAL SAMPLING**			
Region		Southwest Victoria		Gippsland, Victoria		Hunter Valley, NSW		Southern Highlands, NSW	
Year		2001		2006		1998		2005-2006	
Number of samples		60		61		NR		28	
Source		Kane (2004)		McDonald (2013)		Geary & Moore (1999)		Fyfe (2013)	
EC	µS cm^{-1}	4903	(2,031)			3549		3902	(471)
pH		7.4	(0.3)					8	(0.1)
VS	mg L^{-1}							1222	(165)
SS	mg L^{-1}							700	(181)
COD	mg L^{-1}							1412	(323)
Total N	mg N L^{-1}	437	(369)	535	(386)	227	(66)	215	(28)
Ammonia-N	mg N L^{-1}	258	(198)			126	(59)	151	(25)
Total P	mg P L^{-1}	80	(39)	122	(127)	59	(11)	53	(6)
K	mg L^{-1}	410	(243)	484	(256)			463^{a}	(63)
Na	mg L^{-1}	307	(160)					152^{a}	(15)
Ca	mg L^{-1}	283	(446)					99^{a}	(12)
Mg	mg L^{-1}	115	(70)					81^{a}	(11)
Total S	mg L^{-1}	39.6	(42)	143	(181)			19^{a}	(2)

[a] Soluble fraction. Total fraction not analysed.

Table 13.5 Reported secondary pond effluent characteristics (standard deviations in brackets).

		CROSS-SECTIONAL SAMPLING						**LONGITUDINAL SAMPLING**			
Region		Southwest Victoria		Gippsland, Victoria		South East Queensland		Southwest Victoria		Southern Highlands, NSW	
Year		2001		2006		2005		2002 - 2006		2005-2006	
Number of samples		60		61		7		30		28	
Source		Kane (2004)		McDonald (2013)		Skerman (2006)		Jacobs & Ward (2007a; 2007b; 2008), Jacobs *et al.* (2008)		Fyfe (2013)	
EC	µS cm^{-1}	4467	(1,798)			2823	(1,618)	7495	(1,106)	3749	(281)
pH		7.7	(0.3)			8.3	(0.4)	8.1	(0.1)	8.1	(0.1)
VS	mg L^{-1}									923	(114)
SS	mg L^{-1}									411	(111)
COD	mg L^{-1}									981	(216)
TN	mg L^{-1}	196	(178)	286	(268)	175	(98)	163	(27)	171	(30)
NH_3-N	mg L^{-1}	119	(98)					117	(32)	122	(10)
TP	mg L^{-1}	47	(39)	107	(206)	22	(7)	29	(6)	39	(5)
K	mg L^{-1}	364	(204)	474	(447)	85	(57)	461	(52)	480[a]	(59)
Na	mg L^{-1}	348	(222)			158	(107)	598	(108)	158[a]	(14)
Ca	mg L^{-1}	159	(73)			77	(57)	163	(31)	98[a]	(8)
Mg	mg L^{-1}	111	(71)			91	(78)	209	(32)	85[a]	(11)
S	mg L^{-1}	23	(20)	58	(119)			21	(7)	17[a]	(2)

[a] Soluble fraction. Total fraction not analysed.

Table 13.6 Reported single pond effluent characteristics (standard deviations in brackets).

		CROSS SECTIONAL SAMPLING								**LONGITUDINAL SAMPLING**	
Region		South East Queensland		Southwest Victoria		Northern Victoria		Northern Victoria		Northern Victoria	
Year		2005		2001		2006		Not reported		Not reported	
Samples		11		36		12		20		8	
Source		Skerman *et al.* (2006)		Kane (2004)		McDonald (2013)				McDonald (2013)	
EC	µS cm^{-1}	4593	(2,159)	4432	(1,703)			5	(3)	3	(3)
pH		7.6	(0.5)	7	(1)			7.3	(0.5)		
TN	mg N L^{-1}	220	(164)	313	403	429	(279)	311	(209)	230	(277)
TP	mg P L^{-1}	46	(23)	65	(65)	113	(66)	86	(70)	95	(57)
K	mg L^{-1}	394	(331)	316	(173)	479	(192)	361	(256)	421	(309)
Na	mg L^{-1}	268	(190)	304	(199)			231	(299)		
Ca	mg L^{-1}	112	(45)	192	(166)			149	(92)		
Mg	mg L^{-1}	111	(59)	97	(58)			97	(59)		
S	mg L^{-1}			28	(23)	112	(105)	113	(80)	17	(24)

As expected, results varied widely with significant ranges reported across farms (**cross-sectional sampling**). This variation is due to factors such as:

- the age of effluent in ponds,
- desludging frequency,
- time of year sample was taken,
- presence of any solid separation pre-pondage, and
- the level of dilution caused by rainfall, runoff and varying amounts of washdown water.

For these reasons, it is always strongly recommended that farmers sample their own effluent or sludge and base their reuse activities on their own data.

Tables 13.4 and 13.5 generally show that there was less variation on individual farms monitored over time (**longitudinal sampling**). This suggests that without significant changes in operation or management, it is preferable to use the results of previous effluent analyses on a specific farm rather than rely on "typical" data. The variation over time for single ponds (Table 13.6) was higher than for other ponds because of the interaction of the filling and emptying cycle with settled solids.

A complicating factor is that nutrient concentrations in the primary pond will vary with depth. Table 13.7 shows the range in nutrient concentrations (kg/ML) at depth in the primary pond at DemoDAIRY (south-west Victoria) prior to (P) and after (A) agitation.

Table 13.7 Nutrient concentrations at depth (kg/ML) in the primary pond prior to and after agitation

POND DEPTH (m)	NITROGEN (N) (P/A)*	PHOSPHORUS (P) (P/A)	POTASSIUM (K) (P/A)	SULPHUR (S) (P/A)
0	260/370	39/57	510/500	26/62
1	270/700	40/120	510/560	27/200
2	1300/750	210/120	670/550	410/210
3	1700/970	230/150	660/610	470/300
4.5 (bottom)	1400/1500	190/230	620/720	370/530

**P = prior to agitation; A = after agitation.*

Source: Nutrient sampling conducted by John Kane (DPI Warrnambool) and Worldwide Organics Pty Ltd at the Terang Demo Dairy (2003).

The DemoDAIRY data shows that when unagitated, nutrient concentrations in the *first pond* increase with depth for N, P and S but not for K. Agitating (stirring) the pond did have an effect on mixing nutrients throughout the pond. Therefore, be aware that basing your application rate on the nutrient concentration at the top of the pond could mean that you will be out by a factor of over threefold if you use effluent from the bottom. You may be applying excessive amounts of nutrients to some areas and be at risk of burning crops and seedlings.

When emptying a *first pond* that has been collecting nutrients for a number of years, it is recommended that this effluent be applied to an established pasture or to paddocks prior to cultivation.

In other words, apply it *before* sowing a new crop or pasture. Consider taking samples of the agitated sludge as you are desludging the pond and use that data to improve the target application rate next time you desludge. If farm operational details and the desludging period remain close to the previous period, then the data will be useful.

There was no nutrient gradient at depth with the *second* (storage) pond at DemoDAIRY, which indicates that taking a sample at any level in a second pond will give a reasonably representative result.

13.3.4.1 Attributes of a primary effluent pond

- Solids content variable – requires specialised extraction and spreading equipment
- Very high in organic matter
- Higher than 25mm per application could lead to potential risks
- High concentrations of nutrients, especially N, P, Ca & Mg
- Small proportion of nutrients in readily plant available forms
- Most nutrients in various organic forms that require mineralisation over time before plant-available
- Effectively a slow release, sustained release organic fertiliser

13.3.4.2 Attributes of a second effluent pond

- Low solids – comparatively easy to pump and apply
- A high proportion of nutrients in readily plant available forms, but nitrogen responses relatively short lived
- Effectively salty irrigation water with large slugs of urea and potash
- Well suited to:
    - Replacing potassium on hay/silage paddocks
    - Boosting growth of summer forage crops

13.4 Sampling and testing of effluent ponds

Sampling effluent ponds prior to the application of effluent is often recommended to provide a more accurate guide to the nutrient content than can be gleaned from published tables of ‘typical’ values. When sending samples for analysis the following analyses should be requested: Phosphorus (P), Potassium (K), total Nitrogen (N), ammonia-N and salinity (Electrical Conductivity - EC). The ammonia-N content provides a good indication of N availability for plant uptake and use. Knowing P and K content will assist in formulating any subsequent fertiliser requirements for the paddock.

Any laboratory that routinely conducts water testing should be able to test effluent samples.

Any activities conducted in and around effluent ponds must be undertaken with extreme caution as effluent ponds can be very deep, with steep internal walls. It may even be difficult to locate the edge of the pond due to plant growth.

13.4.1 Procedure for sampling:

13.4.1.1 Sample source

As with soil testing, the key to effluent sampling is to take a sample that will represent the effluent being applied to the pasture or crop. In many cases, it would be more appropriate to collect samples from the final pond, the gate valves or even from the pump.

Direct application systems are best sampled at the sump or pump.

Farmers who use flood irrigation would sample at the gate valve, as this is the easiest place to test. It is best to allow the pump or gate valve to flow for at least 10 minutes before collecting a sample.

When sampling from ponds, the following applies. If you intend to desludge the pond, take samples from the sludge layer of the pond. As indicated in Table 13.7, the levels of nutrients at the bottom of the pond will be higher than the liquid fraction at the top of the first pond. If you are only removing the liquid fraction of the first pond without any agitation, take samples from that part of the pond. It would be best to take a sample when the first pond is being stirred. It is, however, unlikely that the pond will be stirred by a contractor, sampled and then stirred again and applied after the results of the test have arrived. If you are pumping from a second or storage pond, the nutrient gradient is relatively constant, so sampling depth is not critical.

13.4.1.2 Equipment required for sampling:

You will need the following equipment for sampling:

- An extendable pole with a clamp at one end to hold a sample bottle.
- A plastic bucket.
- Three or four 1-litre, water-washed sample bottles.
- Insulated carrier boxes.
- Crushed ice.

13.4.1.3 Procedure

Collect 250ml to 500ml samples from various sites around the final pond or from the pump or pipe outlet, using the sample bottle clamped to the pole until 3 to 4 litres have been collected. Collection from ponds should take place close to the surface but should exclude any crust material.

As each sample is collected, place it in the plastic bucket. Hands and foreign objects should not contact sampled effluent or the inside of the bucket.

Each 1-litre, water-washed sample bottle should be filled to the brim with thoroughly mixed effluent from the bucket, unless the sample will be frozen prior to sending it to the laboratory, in which case, leave enough space below the top of the bottle to allow for expansion.

If samples are refrigerated, ensure they reach the laboratory within 2 days of sampling. If samples are frozen, 7 days is acceptable. To prevent unnecessary waiting and sample spoiling, the laboratory should be notified that the samples are being sent.

13.5 Applying dairy effluent and sludge to pastures and crops

Numerous production studies have shown that the application of dairy effluent and sludge to either pasture or crops is an effective way of increasing forage production on-farm.

These studies have demonstrated that this is a desirable way of returning and reusing increasingly valuable nutrients back onto the farm. Further, economic analyses of the results strongly support the costs associated with installing an effective effluent system to contain, store and apply effluent back to farm land. Payback periods are very dependent on the effluent system installed and the various components selected.

Underlying principles for application of dairy effluent and sludge

A number of key principles need to be followed to effectively utilise and safely return effluent and sludge back onto the farm. These include:

- Allow sufficient land area to apply effluent at an agronomically sensible rate to meet the crop or pastures nutrient requirements.
- The main nutrients in effluent are not 'balanced' and each must be considered individually. The nutrient that requires the largest reuse area sets the application rate - see Section 13.5.4.
- Total potassium per application should be no more than **60 kg K/ha**, and no more than **120 kg K/ha** per year. This applies for both liquid effluent and sludge.
- For liquid effluent, the total nitrogen application should be no more than **60-80 kg N/ha**. However, nitrogen application rates as sludge can be much higher due to the slow release nature of much of the organic N in the sludge.
- Heavier applications increase the risk of problems such as nitrate poisoning, mineral imbalances and make less efficient use of the applied N as well as increasing the risk of losses to the environment.
- Treat effluent and sludge as a nutrient source rather than just something that needs disposing of.
- A lighter rate over a larger area is preferable to overloading a small area. If no chemical analysis is available, effluent should be spread at a rate of 1 megalitre per 12 hectares. This is based on typical nutrient concentrations found in surveys of farm treatment systems.
- Apply effluent or sludge to paddocks when there is no likelihood of runoff from the property.
- Rotate effluent applications around at least three or four different areas if possible to avoid excessive build-up of nutrients in the soil.
- Conduct regular soil testing of the areas where effluent is being applied to monitor nutrient levels and soil health.
- Isolate the paddock and restrict cattle grazing for at least 21 days after the application of effluent to pasture or crops. This withholding period will overcome any palatability or fouling issues, reduce the risk of any pathogens and allow the plants time to respond to the nutrients. For direct application of sludge to pasture, up to 6 – 8 weeks may be required due to the solids content.

13.5.1 Strategies to reduce problems

Any effluent or sludge applied to land should not leave the farm boundary or pollute any surface waterway or ground water. In addition, steps should be taken to reduce the risk of odours. Strategies to minimise these risks include:

- Where possible, effluent should be applied to land during the drier months. Applications in the wetter months increase the risk of runoff to streams or leaching to ground water when soils are saturated.
- Apply effluent or sludge on areas well away from watercourses or drainage lines.
- Apply effluent at such a rate that the liquid does not remain ponded for more than one hour after application.
- For all spray applications, use sprinkler nozzles that produce large droplets rather than a fine spray. Note, the lower the nozzle height, the lower the odour potential.
- Where possible apply effluent, or spread sludge or manure during the day rather than in the early morning or late evening when odours can travel further before being dispersed.
- Consider the wind direction and velocity on days when applying effluent or spreading sludge or manure. Adjust application times to suit.
- If the spreading of sludge or manure could result in odour, consider direct injection into the soil, soil incorporation soon after spreading or applying only light rates.

13.5.2 Where and when to apply effluent and sludge

13.5.2.1 Effluent

- Dairy effluent typically contains relatively large amounts of readily plant available nutrients, particularly nitrogen (N) and potassium (K) in addition to a range of other essential plant nutrients. Depending on the farm, the effluent can also be quite saline.
- Best plant growth responses are obtained when effluent is applied to actively growing crops or pastures in the warmer months of the year. This is due largely to responses to the N content and to a lesser extent the water content. Forage crops, such as turnips or rape, have been found to give excellent responses to effluent. Responses to actively growing pastures are good, but considerably lower for drought stressed or dormant pastures.
- Due to its usually high salt content, effluent should not be regarded as an irrigation water. While plants do respond to the water content, application rates should be based on the nutrient (especially N and K) content of the effluent rather than water requirements. Effluent can be shandied with irrigation water to reduce the salinity levels.
- Again due to the salt content, effluent should not be applied to young seedlings or to irrigate a crop up due to the risk of burning.
- The application of effluent is also an effective way of increasing the K content of soils. This can be a useful method of correcting induced low soil K levels in paddocks that have been repeatedly cut for hay or silage.
- Where possible effluent applications should be synchronised with herd and paddock rotations to allow sufficient time between application and grazing. A standard practice is for at least a 21 day interval to allow time for the pasture to respond and reduce pathogen risks.

13.5.2.2 Sludge

- Dairy sludge extracted from the bottom of treatment ponds is physically and chemically quite different to the liquid effluent. Its high solids content, typically 6-8% DM as spread, requires specialist handling equipment which influences when and how it can be used.
- Importantly, while a proportion of the nutrients such as ammonium-N in the sludge are in readily plant available forms, the majority of the nutrients are in various organic forms. These need to be mineralised to convert them to plant available forms. As a result, applied sludge acts as a long-acting, slow-release nutrient source for pasture and crop growth.
- Sludge can be applied directly to established pasture, preferably in the drier months, to enable the water content to drain and evaporate off leaving the nutrient rich solids on the soil surface. These solids then act as an effective, long-acting nutrient source. Direct applications at wetter times of the year run the risk of rainfall washing these solids off the pasture.
- Application rates are usually limited by trafficability over the spread area and typically are not more than 5 – 10 mm (50,000 – 100,000 L/Ha).
- Sludge can also be applied to cultivated ground and incorporated into the soil prior to sowing of a crop. As with direct application to pasture, this is best done in the drier part of the year.
- Overseas, sludge is often injected directly into soil using specialist equipment. This minimises odours and N losses by ammonia volatilisation. However, suitable equipment is not commonly available in Australia.

13.5.2.3 Manure

See the following links for information on the re-use of manure:

- Land application of manure and pond sludge
- Making the Most of Animal By-Products

13.5.3 Worked example; calculating application rates when applying effluent.

Scenario; effluent is to be applied to grazed pasture with the nutrient application to not exceed 60 to 80 kg N each application (see Section 13.5.1) or 120 kg K annually. The nutrient concentration in the effluent was tested to be 200 mg total Nitrogen per Litre, 30 mg P/L, and 400 mg K/L.

Often, testing laboratories report nutrient concentrations in effluent using units of mg/L (milligrams per litre). Fortunately, this is equivalent to expressing nutrient concentration as kg/ML (kilograms per megalitre) which is a more useful measure.

It is also useful to know that an application rate of 1 ML/Ha is equivalent to a depth of 100mm. Therefore a 10 mm application of effluent represents and application rate of 0.1 ML/Ha.

The target application depth can be calculated according to:

$$\text{Target application depth (mm)}=\frac{\text{nutrient application rate }\left(\frac{\text{kg}}{\text{Ha}}\right)}{\text{effluent analysis }\left(\frac{\text{kg}}{\text{ML}}\right)}*100$$

	N	**P**[1]	**K**
Effluent test results (mg/L)	200	30	400
Maximum nutrient application rate per application (kg/Ha)	60-80		60
Maximum nutrient application rate per year (kg/Ha)		30	120
Application rate to not exceed maximum per application (mm)	30-40		15
Application rate to not exceed maximum per year (mm)		100	30

[1] Refer to Chapter 15.6 to 15.8 for more information about P requirements

Clearly, potassium is the limiting constituent in this example – it limits the effluent application to a total of 30 mm in any year. While that could occur in two applications of 15mm, or even three of 10 mm each, it is well less than the limit imposed by nitrogen of 30 to 40 mm per application or 100 mm per year for phosphorus.

The application rate should be set by the limiting constituent and shortfalls in supply of the other nutrients can be made up by applying conventional fertiliser.

13.6 References

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