APPENDIX 2

Best practice guidelines for using poultry litter on pastures

by

NSW Agriculture

Agnote

Best practice guidelines for using poultry litter on pastures

NSW Agriculture

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Summary

Bulk poultry litter can be the basis of very productive and valuable pasture and agricultural production when used wisely. It also has potential to cause dust, smell and water pollution if it is not stored, spread and managed in an appropriate manner. These guidelines aim at ensuring you use poultry litter wisely to optimise pasture production and minimise the risk of pollution and environmental problems.

The nutrient content of poultry litter varies. This variability must be reflected in its price compared to other forms of fertiliser.

Poultry litter contains the major nutrients nitrogen, phosphorus and potassium but it is NOT balanced for pasture requirements. It supplies too much phosphorus compared to nitrogen and potassium.

Wise fertiliser use combines nutrient budgeting (knowing what nutrients are being used and removed from a paddock) with soil testing (to check that the desired soil nutrient levels are being achieved).

Poultry litter is light and will wash off paddocks easily. Take care when storing and spreading poultry litter to prevent it entering

watercourses or moving to off target areas. It may sometimes be possible to plough it into the soil, however this practice destroys established pasture and increases soil erosion risk.

Spreading litter onto a recently grazed or harvested pasture with 5cm to 10cm of stubble will help to hold the litter in place and reduce washing. To further protect waterways, maintain an unfertilised vegetated buffer 10m to 30m wide around all boundaries and next to any watercourses. The width of the buffer will depend on slope, groundcover and sensitivity of the waterway to pollution.

As a general guide, on intensive irrigated pastures expect to apply 15m^3/ha for the first two or three years then soil test to check that phosphorus has risen to the desired level. Then expect to alternate one year poultry litter to one year nitrogen or potassium fertiliser if required. On less productive dry land or grazing paddocks the same principle applies but less fertiliser may be required to maintain target fertility levels.

These guidelines should be appropriate in most situations, however it is always the user's responsibility to ensure that water is not polluted and offensive odours are not created.

What is poultry litter?

Bulk poultry litter is a mixture of manure, bedding material and water. The proportion of each will vary depending on shed management. A typical analysis of poultry litter is shown in Table 1.

Table 1. Poultry Litter Analysis

	Average	Range
pH	8.1	6.0 - 8.8
Electrical Conductivity* (ds/m)	6.8	2.0 - 9.8
Dry Matter %	75	40 - 90
Nitrogen (N)% of dry matter	2.6	1.4 - 8.4
Phosphorus (P) % of dry matter	1.8	1.2 - 2.8
Potassium (K) % of dry matter	1.0	0.9 - 2.0
Sulfur (S) % of dry matter	0.6	0.45 - 0.75
Calcium (Ca)% of dry matter	2.5	1.7 - 3.7

Magnesium (Mg) % of dry matter	0.5	0.35 - 0.8
Sodium (Na) % of dry matter	0.3	0.25 - 0.45
Carbon (C) % of dry matter	36	28 - 40
Weight per m^3 (kg)	550	500 - 650

* Electrical conductivity is a measure of salinity measured as a 1:5 suspension

Litter also contains trace elements including copper, zinc, manganese, boron and chloride.

As a normal safety precaution check that the bedding material does not contain chemicals that could cause a residue problem in livestock that may graze littered areas.

The nutrients in poultry litter are in both mineral and organic forms. This means a proportion of the nitrogen, phosphorus and potassium is immediately available to plants while the remainder (organic) must react in the soil to change into a form which is available for plant use.

Most of the nitrogen in poultry litter is available soon after spreading. Approximately 25% (range 10%-50%) is in the ammonia form which will be lost to the atmosphere unless cultivated or washed into the soil within a few days of spreading. Most of the other nitrogen in poultry litter becomes urea within a short time of spreading and from then on acts similarly to urea fertiliser.

If washed or incorporated into the soil by rain or irrigation it will soon become available for plant growth. If not it will be lost to the atmosphere.

Excessive nitrogen should not be applied to pastures. It may leach into groundwater or wash into surface waters causing a potential health problem. Excessively high nitrogen levels in pasture may also be a poisoning risk for grazing animals and any sensitive native vegetation.

Approximately 13% (range 6%-30%) of the phosphorus in poultry litter is in a water soluble form which means that it is immediately available for plant use. The remainder is slowly released as organic fractions of the litter decompose, usually within a year of application. Leaching is not normally a problem because most soils bind phosphorus.

Potassium in poultry litter is readily available to plants. Some may be lost by leaching down into the subsoil if excessive rain or irrigation occurs.

Litter is normally alkaline with a pH around 8, however it has a lower neutralising effect on acid soil than lime. (The high pH is mostly caused by the ammonia contained in the litter.) Repeated use of poultry litter will maintain or slightly increase soil pH. On soils that are very acidic, mixing lime into the soil will improve pasture growth.

Moisture content in litter is variable which is one reason why it is sold by volume (m^3) rather than weight (tonnes). Moisture content will affect the amount of dust and overlap required when spreading. It is also important when calculating the rate of nutrient being applied to a paddock.

Poultry litter is mostly organic matter. Organic matter helps hold moisture, improves soil structure, encourages organisms such as earthworms and will hold and supply nutrients. Any increase in organic matter will normally improve your soil.

Storing poultry litter

Ideally poultry litter should be spread directly from the shed at cleaning time. This minimises double handling and maximises nutrient value. Unfortunately limited cleanout time, availability of equipment, weather conditions and availability of suitable land often means that litter must be stored for some time prior to spreading.

Proper storage of litter is essential to maintain its fertiliser value and minimise the risk of pollution. Poultry litter stored in large piles at incorrect moisture levels will heat up and lose nitrogen and organic matter. This is often seen as a blackened or ashy grey colour of the litter. In extreme situations large piles can ignite by spontaneous combustion.

Loss of nutrients during storage is also an environmental concern. Nitrogen and phosphorus can wash from stockpiles into streams or dams or leach into groundwater.

Storage methods will vary depending on local regulations, amount to be stored, time period and weather conditions. The cheapest and most common method is an open stockpile. A large stockpile has the greatest risk of nutrient loss and environmental pollution. For an open stockpile select a well drained site away from watercourses. Narrow stacks no more than 1.8m high will reduce nitrogen and organic matter loss caused by overheating.

Nutrient losses and environmental pollution risk can be reduced by covering the stack with a roof or plastic sheeting. A compacted base and bunding will reduce runoff in sensitive locations near waterbodies. A sediment fence could also be useful.

Composting poultry litter

When composting poultry litter manage it to achieve an even and effective process. Ideally it should have a carbon to nitrogen ratio of 30:1 and moisture content of 40-50 percent.

A low carbon:nitrogen ratio will result in extensive loss of nitrogen which would be a problem if straight poultry manure was used. Litter should be heaped in rows approximately 1.2m high and 2.4m wide to achieve temperatures of 60° C to 70° C. This temperature is enough to kill most pathogens except *Listeria* and *Clostridium perfringens.* If litter is stacked too deep temperatures can exceed 95° C and result in fire.

Composting poultry litter may reduce the risk of nutrients from poultry litter entering watercourses. In practice poultry litter is often partially composted during storage in heaps before it is spread onto crops or pastures. This may result in 45-55% of the manure nitrogen being lost during storage. Composting reduces the weight and volume of the original material.

Although kilo for kilo compost may be a more valuable fertiliser than fresh poultry litter, it has the disadvantages of increased cost and time required for processing and reduces the total amount of nitrogen and organic matter available for land application.

Farmers who use poultry litter on crops and pastures need to be aware of the effect of the composting process on nitrogen and organic matter availability. They need to be aware that losses will occur during storage and that these losses will increase if the litter is stacked too deep. In very cost sensitive industries it may be more profitable to apply fresh poultry litter which minimises cost and maximises total nutrient input and use other management strategies to ensure that nutrients from poultry litter do not enter watercourses.

Composting poultry litter would be economically justified if the composted product could be sold for a premium for use in nurseries and gardens.

How much poultry litter to use

Typically, poultry litter is spread at a rate of approximately $15m^3$/ha. Using the average analysis provided in Table 1, $15m^3$ would supply 160kg nitrogen, 111kg phosphorus and 62kg potassium. This is equivalent to 350kg urea, 1260kg superphosphate and 125kg muriate of potash.

Whether this amount of fertiliser is enough, not enough or too much depends on soil type, crop requirements and the amount of nutrient being removed in animal products, silage or hay.

In many situations it would be desirable to split the application of poultry litter into smaller amounts, possibly applied more frequently.

The problem with this alternative is that it is either not possible or excessively expensive if contractors are used to spread the litter and many spreaders are not able to spread smaller amounts (eg. 6m^3/ha) evenly and efficiently. You need observation, a soil test and a nutrient budget to determine what rate of poultry litter to apply and to check that you are getting the desired result.

Soil test

You should have your soil tested for pH, electrical conductivity (salinity), phosphorus, sulfur, calcium, magnesium, potassium, sodium and aluminium. Nitrogen may be included in this test package.

Test paddocks every two or three years. Samples should be taken nine months after the last application of litter.

Where heavy rates of poultry litter are used, the amount of available phosphorus in the soil often exceeds desired levels. To save money and reduce the chance of environmental problems you should temporarily stop using poultry litter or other fertilisers containing phosphorus if soil test results are more than two times higher than targets (eg. more than 60 Bray or 120 Colwell). It is highly unlikely that pastures will respond to additional phosphorus if soil levels exceed these limits. Losses of phosphorus in runoff are more likely to occur if excessive phosphorus is applied to the soil.

Nutrient budgeting

Poultry litter is normally applied where high levels of production are desired. You can calculate what nutrients are being removed from the paddock using Table 2 then plan your fertiliser program to replace these nutrients.

Table 2.

Nutrient	Guide to nutrients removed in :				
	Lucerne kg/tonne Dry Matter	White Clover kg/tonne Dry Matter	Ryegrass kg/tonne Dry Matter	Kikuyu kg/tonne Dry Matter	Milk kg/10,000 L
Nitrogen (N)	40	40	32	24	50
Phosphorus (P)	3.5	3.5	3.5	3.5	9
Potassium (K)	25	24	20	27	14
Sulphur (S)	2.5	2.5	2.5	2.0	4
Calcium (Ca)	15	12.5	3.6	2.7	12
Magnesium (Mg)	3.0	3.0	2.4	3.0	1

(Mg)

Using poultry litter on pastures

Poultry litter can be used to fertilise all types of pasture. The best results are obtained from mixed pastures comprising grasses and legumes. The following special considerations also apply:

Poultry litter on lucerne or clover

Lucerne and clover respond very well to poultry litter. They contain large amounts of nitrogen, potassium and calcium. Poultry litter will supply ample phosphorus but lack of potassium may limit legume growth. This will depend on the potassium content of the litter and the natural potassium level in the soil.

Lucerne and clover will use nitrogen supplied by poultry litter or, being legumes, fix their nitrogen requirement from the atmosphere. To prevent nitrogen being wasted, rotate legume paddocks with a grass pasture or forage crop otherwise you will get weeds or nitrogen may leach, polluting groundwater and making soil more acid.

Poultry litter on kikuyu

Poultry litter works well on kikuyu. Litter will provide excess phosphorus compared to the amount of nitrogen and potassium required by kikuyu.

Nitrogen is normally the nutrient which limits kikuyu growth when temperature and moisture are right. Poultry litter will supply some nitrogen. Unless a vigorous legume such as white clover is also in the pasture, kikuyu will require extra nitrogen fertiliser as urea or ammonium nitrate (Nitramâ) to grow to its potential.

If poultry litter is used to supply the full nitrogen requirement then excess phosphorus will be applied, which is a waste of money and nutrient and could become a pollution risk.

Grasses generally have a vigorous root system able to extract enough potassium from the soil. Kikuyu will not normally show an obvious response to extra potassium but if you wish to grow white clover or lotus with kikuyu, extra potassium may be required.

Managing pasture that has received poultry litter

Pastures that have been fertilised with poultry litter are intended to produce large amounts of high quality forage. To be successful this forage must be harvested or grazed at its optimum growth stage. If it is allowed to become old and rank its feed quality will deteriorate and because of trampling, shading and lodging, it will be wasted.

Grazing

Spread poultry litter on high quality improved pastures. In general, graze grass based pastures when they are short and have maximum quality. The optimum is usually 15 to 20cm in height and before there is any yellowing or death of shaded lower leaves.

Rotational grazing is often required for best growth and utilisation of intensive pastures. Slashing or mulching may be required to remove old stems and residue after grazing. This will ensure regrowth is high quality and will reduce future waste. (Details on the best grazing management for each pasture species is available on request.)

Don't graze pastures for at least three weeks after spreading poultry litter. This will normally coincide with the regrowth period if litter has been spread on a well grazed paddock. The three week wait for new growth will minimise palatability problems and reduce any risk of disease carry over from the litter (such as *Salmonella* or *Botulism*).

Silage

Improved pastures topdressed with poultry litter are usually very productive and high quality. The only special consideration is not to make silage from the first regrowth after topdressing with poultry litter. This will reduce risk of disease (such as *Salmonella* and *Botulism*) developing in the silage.

Provided the pasture has been grazed at least once since topdressing with litter these paddocks should make good silage.

Managing the buffer strip

The aim of a buffer strip is to catch and filter any litter or nutrients before they move off your property.

A permanent grass such as kikuyu is most effective but it may be used in combination with trees or other vegetation.

The buffer strip should not be fertilised or used as a stockcamp but may otherwise be used normally. Maintain a moderate height of pasture (10cm) especially when litter has recently been spread on adjacent areas.

Ideally, the buffer would be harvested as hay, silage or mulch to minimise any nutrient accumulation in this area. If this is not practical the area may be rotationally grazed. Remember, cow manure will wash and cause similar side effects to poultry litter (nutrients and faecal coliforms) if it gets into water.

Proper application of poultry litter

Broadcasting is the most common and practical way to apply poultry manure. Spreading may be followed by incorporation where possible, however in a pasture situation the litter requires rain or irrigation to wash it into the soil.

Calibrate equipment to apply litter evenly across a paddock. It should be applied and cultivated into the soil where possible to reduce smell and losses of nitrogen into the air.

Timing and site selection are the main variables which the farmer can control. The way litter is handled and applied will determine its value and fate.

Litter should not be applied to steep land. Also keep away from rock outcrops, streams, dams, wells or dwellings. A 10m to 30m buffer is commonly recommended to minimise the effect of litter on water supplies. Application should coincide with the main growing season of the crop or pasture. It should avoid heavy rain if possible.

Consider wind and weekends when spreading litter to try to minimise conflicts with neighbours. A shrouded cover attached to the back of a broadcast spreader will help reduce dust and ensure a more even application of litter across the paddock.

Calibrating application equipment

Correct application of poultry litter to crop or pasture land is critical to maximise its fertiliser value and not create environmental problems. Here are three alternative ways to determine application rates:

- Weigh the spreader empty then again when full. Spread the load under normal operating conditions then measure the width of spread and distance it took to unload the litter and calculate the area covered. The application rate in tonnes of fresh litter per hectare can then be calculated. **Note :** Knowing the volume of the spreader will allow calculation of volume (m^3) per hectare applied which is the most common method of measuring litter application in New South Wales. Application based on volume reduces variation caused by changes in moisture content of litter.

- Know the average weight (or volume) per load, count the number of loads it takes to spread litter over a known area eg. a measured paddock or a measured hectare. Calculate the average weight (or volume) applied per hectare.

- Another method is to lay a tarp or trays in the field. When the spreader has passed, collect and weigh the collected litter.

Measure the area of the tarp or trays and calculate the application rate. Reliability will be improved by repeating this procedure several times and averaging results. Application rate can be changed by changing speed across the paddock or adjusting the spreader.

Comparing the cost of poultry litter to other fertilisers

Comparing poultry litter with its variable nutrient analysis and wide range of components including organic matter will always require some approximation. The method suggested here is to compare the best available estimate of nitrogen, phosphorus and potassium contained in the litter with what it would cost to buy the same nutrients in commercial fertilisers. The organic matter, calcium, magnesium, sulfur and trace elements are not normally given a value, however this technique could be used to value any nutrients which are required.

The following example compares the cost of poultry litter at Maitland to the commercial fertilisers urea, trifos and muriate of potash:

Table 3. Example cost of nutrients

Urea	$490/t @ 46% N	=$1.04/kg N
Trifos	$420/t @ 20.7%P	=$2.03/kg P
M of Potash	$370/t @ 49% K	=$0.76/kg K

Poultry Litter

Cost $15/$m^3$ delivered and spread

2.5 m^3 fresh litter = 1t dry litter

Cost = $37.50

Assuming average analysis of 2.6% N, 1.8%P and 1.0% K on a dry weight basis

1t dry litter contains 26kg N, 18kg P, 10kg K

If the same nutrients were supplied using urea, trifos and muriate of potash the cost (from table 3) would be:

Table 4. Example Value of nutrients in 1 tonne of dry litter

26kg N @ $1.04	$27.07
18kg P @ $2.03	$36.54
10kg K @ $0.76	$ 7.60
Total	$71.21

However not all nutrients in the litter will be available in the year of application. Assuming 70% of N and 80% of P and K are available the equivalent fertiliser would cost $54.26

If these assumptions are correct at the prices in this example farmers could afford to pay up to $20/$m^3$ for poultry litter. These calculations could be repeated using different fertilisers and prices. Some allowance may also be made for nutrient availability, losses and spreading cost when commercial fertilisers are used.

The price comparison changes dramatically if litter is being spread on land with a high phosphorus level*. In this case a growth response is not expected from the phosphorus, therefore it is given no value. Hence 2.5m^3 of litter costing $37.50 is compared with

26kg N x 0.7 (availability) @ $1.04 and

10kg K x 0.8 (availability) @ $0.76 = $25.
In this case litter would be more expensive than alternative fertilisers and it would not be recommended due to the risk of excess phosphorus contributing to environmental pollution.

*This situation can arise after repeated applications of poultry litter because plants do not require all the phosphorus that chicken litter can provide if it is applied to meet their nitrogen requirements.

Used efficiently litter can be very cost effective, however, if used in inappropriate situations it is expensive and wasteful.

Best management practice for using poultry litter on pastures is supported by:

- Karuah-Great Lakes Catchment Management Committee
- Williams River Catchment Management Committee
- Hunter Catchment Management Trust
- Dungog-Gloucester Dairy Development Team

Further reading

N. Griffiths (1998) *Poultry Litter : A great resource or an environmental hazard* NSW Agriculture

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upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Agriculture or the user's independent adviser.

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