# Poultry litter as a fertiliser: 30 years of development

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**Abstract:** *Understanding and attitudes to the use of poultry litter as a fertiliser have changed over time. Testing and monitoring of both poultry litter and soils where it has been applied have contributed to changes in the way it is used. The answer to the question 'Is poultry litter a great resource or an environmental hazard?' is 'It can be both'. It is a great resource and management today aims to maximise the benefits and minimise any problems. Using poultry litter as a phosphorous fertiliser has reduced most of the overuse issues seen in the past. It is a variable product which contains most macro and micro nutrients plus carbon. These nutrients are not perfectly balanced but can provide a cost effective base for a fertiliser program to be supplemented with other fertilisers as required.*

**Key words:** chicken manure, soil fertility, pasture growth, pathogens, disease risk

## In the beginning

When I began working with poultry litter (PL) in the Hunter Valley NSW in the 1980s it was mainly considered a waste disposal issue for the broiler (meat) chicken industry. The main concern was water pollution as it was often applied at excessive rates by poultry producers onto their own properties. At this time PL was mainly considered a nitrogen (N) fertiliser which contained other nutrients. There was no restriction on ruminant animal access to poultry litter in stock piles or when spread on paddocks. Repeated high applications as an N fertiliser led to a build-up of high levels of phosphorus (P) in soil and associated increased risk of P runoff. The latter is considered a contributing factor to blue-green algae developing in still water in hot weather (CSIRO 2019).

In the 1980s multi-batch litter was produced from an annual clean out of broiler sheds, with lime sometimes spread on litter between batches of chickens. This influenced soil test results in 1997 when soils from paddocks with a history of PL application were compared with nearby paddocks which had received superphosphate or nil fertiliser (Griffiths 2000b). Major findings from this comparison were the increase in average soil P levels from 37 to 360 ppm (Colwell) and average soil $pH_{Ca}$ 4.7 compared to 5.3 where PL had been repeatedly applied.

At about the same time a range of PL from the Lower Hunter and Central Coast was tested for nutrients and trace elements. Nutrient analyses of 22 single batch poultry litter samples showed average total nitrogen N = 4.9%, P = 1.8% and potassium (K) = 1.4%. These levels were the source commonly referred to in a number of publications including *Poultry Litter: A great resource or environmental hazard* (Griffiths 1998) and *Best Practice Guidelines for using poultry litter on pastures* (Griffiths 2000a). Although PL was alkaline due to its ammonia content, lime was not applied to single batch litter and so it did not have the same neutralising value as seen in later studies.

Management systems in broiler sheds changed after 1997 from naturally ventilated open-sided sheds to enclosed tunnel ventilated systems. This coincided with increased stocking rates, changes in type of material used for bedding and changes in diet. As reported in Griffiths (2015) a mix of 38 broiler, turkey and layer sheds were sampled in 2010 with the major change from 1997 analyses being a drop in average P content in broiler litter from 1.8 to 1.1% P. This reduction was mainly attributed to a change of diet with the introduction of phytase enzyme improving efficiency with less P being fed to and excreted by broiler chickens. Average P levels in turkey litter (1.7% P) and layer manure (2.2% P) remained similar to previous testing.

A knowledge of nutrient values in PL and the affect it had on soil test results led to recommendations that PL should primarily be used as a source of P rather than focusing on N. Comprehensive nutrient analysis of PL meant that application rates and costs could be compared with other fertilisers leading to greater appreciation of the fertiliser value of

PL and its application to a larger area by more producers. Effectively it meant reducing PL use in areas with a long history of PL application and applying it to new areas where soil tests showed P was needed. It was particularly cost effective when developing land that was deficient in most major nutrients and trace elements. In these situations it became known as 'half price fertiliser' due to its NPK value compared to other fertilisers. By focusing on soil testing and using PL as a P fertiliser most of the previous overuse issues could be avoided. Testing of PL has added to the understanding that it is an inherently variable product, which should be considered when sampling, testing, costing and using it as a fertiliser.

## Some other changes

Over time understanding and attitudes have changed toward using PL as a fertiliser. While it is standard practice in some areas it is contentious in others especially where communities are not familiar with the product. In response, NSW Department of Primary Industries developed guidelines and training for producers, contractors and users to support the use of PL as 'a great resource not an environmental hazard'.

## Pathogens and disease risk

Poultry litter is manure and can contain pathogens, so the poultry industry has developed guidelines to reduce disease risk within its industry. The grazing industries are more concerned about disease risk to grazing animals which has led to the adoption of two practice changes:

- The mandatory exclusion of grazing animals from PL dumps, storage sites and paddocks where PL has been spread for at least three weeks or until poultry residue is not present. This withholding period is considered sufficient to facilitate the environmental degradation and inactivation of pathogens due to sunlight and desiccation.
- Vaccination of cattle to protect them from botulism. Botulism is not common where PL is used on pastures but can be devastating if it occurs.

## Poultry litter use in cropping areas

As poultry production has increased in inland grain producing areas such as Tamworth and Griffith, use of poultry litter as a fertiliser on crops has also increased. Applications of PL can have both positive and negative effects in cropping. Deep application of high rates of PL into sodic subsoils in the high rainfall cropping zone in Victoria was found to be profitable despite the very high cost (Lush 2013; Sale *et al.* 2015). However, excessive PL applications on crops can reduce grain yield by promoting vigorous early growth with associated increased water use and risk of lodging and/or moisture stress toward the end of the growing cycle (Rural Directions 2015).

## Value adding poultry litter

To date most attempts to value add to poultry litter have increased costs to the end user but not increased returns to the poultry farmer. Pelleting provides convenience when handling and applying through standard machinery. But the nutrient content of pellets depends on the type of manure used, whether it is composted and if other nutrients are added. The pelleting process often means the cost of nutrients in the pelleted product is double that in the raw manure. End users must decide if convenience, reduced pathogen risk and any changes in nutrient balance provide good value.

Composting is used to reduce the volume of PL to be handled, reduce pathogen risk and provide a more stable product. Ideally PL will be mixed with straw or other carbon sources for efficient composting. It must also be turned and maintained at ideal moisture levels to achieve temperatures required to kill pathogens. The volume of PL will commonly halve when composted thereby reducing transport and application costs. However, the time and labour required for composting adds to the cost of production and composted PL has less N than raw PL. End users must decide if the reduced pathogen risk and any changes in nutrient content provide good value. Often PL will age in a storage area with associated changes in volume and nutrient content but this aged litter is not turned and properly composted so still contains a pathogen risk.

## Tocal trial contributes to understanding

A trial was established on a kikuyu (*Pennisetum clandestinum*)/ryegrass (*Lolium multiflorum*) pasture at the Tocal Agricultural Centre dairy in 2002. Initially the trial was used to measure N and P in runoff from three treatments with two replications. The treatments were (1) Litter – 15 $m^3$ of PL applied annually, (2) BMP – 15$m^3$ of PL applied every second year plus 100 kg/ha urea (46% N) every 3 months, (3) Fertiliser - applied equivalent NPK to Treatment 1 using di-ammonium phosphate (18% N, 20.2% P, 1.5% sulphur), urea and muriate of potash (50% K). After three years the runoff project was completed but the trial site was maintained for a further 12 years. Treatment 3 was changed to monthly applications of 100 kg/ha urea when the pasture was actively growing as high levels of P had accumulated. Pasture growth was measured using pasture cages and soil testing was continued.

As can be seen in Fig. 1 the site was high in P when the trial started due to the initial focus on monitoring nutrient runoff. There was variation across the three treatments but generally the annual PL applications more than doubled the P levels in the period 2002–16. The BMP treatment roughly maintained P levels, while P levels fell in Treatment 3 but still had adequate P despite applying only urea for 10 years. Subsequently, there was a drop in soil pH with the urea only treatment compared to the PL treatments (Fig. 2).

Pasture growth varied from year to year depending on seasonal conditions and management as can be seen in Fig. 3. Total pasture dry matter production for the duration of the trial (15 years) for each treatment was Litter (Treatment 1) 190 t DM/ha, BMP (Treatment 2) 202 t DM/ha and Fertiliser (Treatment 3) 203 t DM/ha. Considering all treatments had excessive P levels it is considered that pasture growth was mainly limited by water, when not irrigated, and N levels. As with past comparisons (Griffiths 2009) if current fertiliser costs were applied to these yields then PL would be very cost effective but this may vary depending on

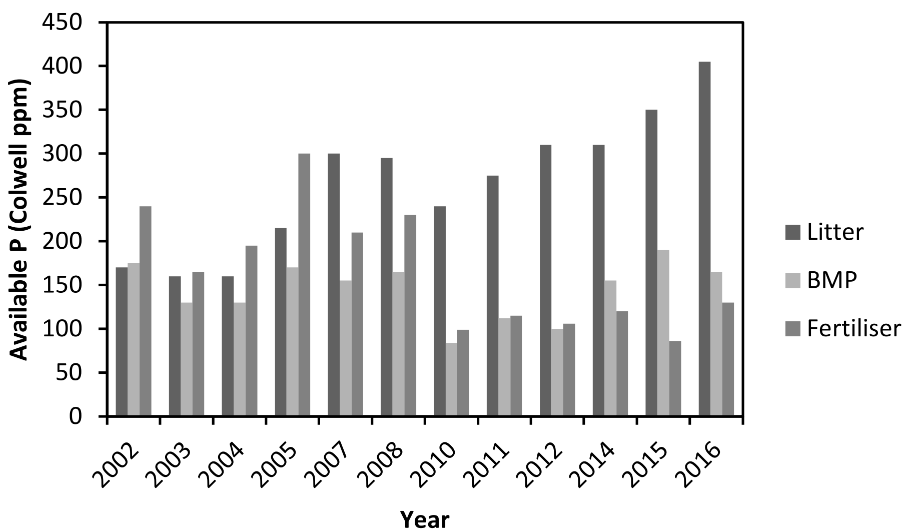


**Figure 1. Changes in available soil phosphorus (P, Colwell, ppm, 0–10 cm) from three treatments in a poultry litter trial at Tocal Agricultural Centre.**

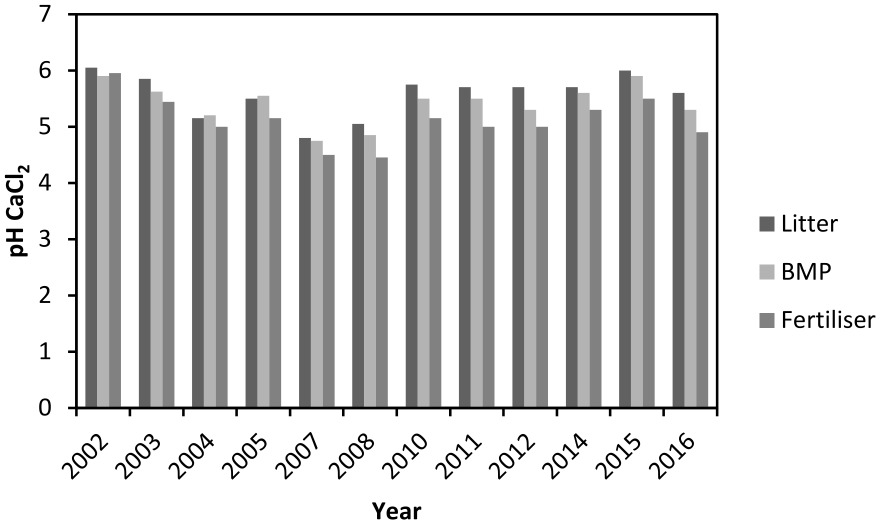


**Figure 2. Changes in soil pH ($CaCl_2$, 0–10 cm) from three treatments in a poultry litter trial at Tocal Agricultural Centre.**

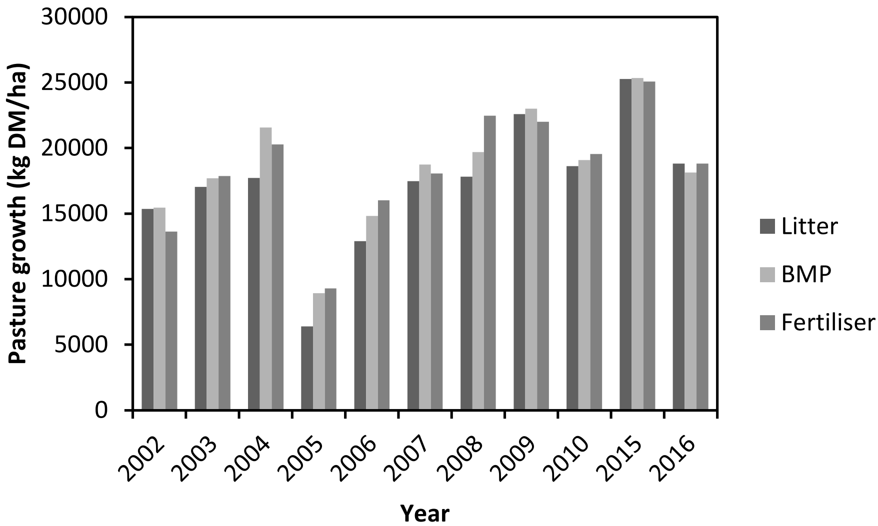


**Figure 3. Annual pasture growth (kg DM/ha) from three treatments in a poultry litter trial at Tocal Agricultural Centre.**

costs for PL and fertiliser from year to year. The PL would be much more cost effective in a situation where a P response was expected, remembering this site was already high in P.

## The future

In future, PL will continue to be a valuable fertiliser resource if used wisely. It will be cheapest if used close to the source and if application rates are based on soil test results to ensure maximum benefit is obtained from the nutrients and organic matter it contains. The environment and neighbours must be considered when transporting, storing and applying PL to ensure that it can continue to be used sensibly and without prohibitive regulation.

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