

Waste to resource – chicken litter versus biosolids

KATHERINE MAITLAND

Using chicken litter or biosolids as fertilisers has been shown to improve soil health and crop productivity, but which is the better option?

Chicken litter and biosolids - reclaimed solids from human-waste treatment works - are both recycled organic waste products that can improve the activity of organic matter and organisms in the soils, increase N and P levels and contribute to improved crop yields.

Tony Craddock, a Rural Directions Agribusiness Consultant who has worked with chicken litter and biosolids, says both products are beneficial. Which is better in a particular situation will depend on the economics, which are strongly influenced by the proximity of the farm to the source.

"Biosolids are a cheap source of a range of plant nutrients, including nitrogen (N), phosphorus (P) and trace elements," Tony said. "Most farmers spread them on cropping paddocks in autumn at rates of around 5t/ha and they are incorporated by the sowing operation. Some farmers are using them on low-fertility paddocks to boost background fertility."

"Chicken litter, which is usually made up of chicken manure and bedding material, also contains N, P and trace elements and can be a fantastic soil improver," he said.

Between 2007 and 2011, Tony and his team at Rural Directions conducted a series of trials comparing chicken litter with traditional fertilisers with the aim of measuring the effects of litter on crop growth and identifying appropriate use patterns for it.

"In some trials crops treated with chicken litter alone showed less early vigour than crops sown with conventional fertiliser placed close to the seed, particularly in low-disturbance sowing systems, but in most cases eventual grain yield was not affected," Tony said. "However, there were instances where yields were slightly lower in crops fertilised with chicken litter than where conventional fertiliser was used."

"Further investigation indicated this low vigour was largely associated with soils low in background P levels, probably



TONY CRADDOCK, AGRIBUSINESS CONSULTANT WITH RURAL DIRECTIONS.

because the P in the chicken litter was less available than that in conventional fertiliser or less accessible in modern no-till farming systems.

"Where some conventional fertiliser was applied in the seed row at sites with low background P, the problem was mostly overcome."

The trials showed chicken litter to be a helpful soil supplement, but there were some issues with nutrient availability.

Biosolids are generally easier to handle than chicken litter or pig bedding.

"Some of the nutrient in chicken litter is in an organic form, which can result in reduced availability of nutrients as the litter is broken down by soil microbes.

"To complicate the issue, chicken litter is broadcast onto the soil surface, and in no-till farming systems the minimal soil disturbance means there is little incorporation of it during seeding. As a result, there may not be a lot of nutrient from the litter in the vicinity of the establishing crop plant, reducing accessibility of the nutrients," he said.

Combining chicken litter applications with a P-based fertiliser applied in the seed row at seeding will ensure establishing crop plants are supplied with vital nutrients, he suggests.

"We recommend applying at least some conventional P-based fertiliser with the seed when using chicken litter in P-responsive soils or soils where growers are unsure of their nutrient status to ensure the crop plants have immediate access to some nutrients.

"To maximise utilisation of N in chicken litter it would be ideal to spread the litter immediately ahead of seeding so it is incorporated into the soil soon after application or aim to apply it just prior to rainfall so the N is washed into the soil.

"Chicken litter provides useful amounts of trace elements that can build soil levels in the longer term," he said, "but be prepared to address potential deficiencies with foliar nutrient sprays in crops grown on deficient soils."

Chicken litter is currently priced between \$8 and \$12 per cubic metre, but it is important to consider transport and spreading costs as well as the unit cost when calculating whether or not it will be economic to use litter instead of a chemical fertiliser, Tony said.

CHICKEN LITTER BOOSTING SOIL BIOLOGY

Freeling farmer Gavin Schuster has been using chicken litter as an organic fertiliser on his 1,900 ha farm for 15 years, spreading 1,500 to 2,000 tonnes of chicken litter each year.

He has noticed a significant increase to soil health and a peak in crop yields since beginning to use chicken litter.

"We started applying it to poorer-performing paddocks about 15 years ago and now use it on 600 to 800 ha each year, varying the rate according to soil type and what we plan to grow in each paddock that year," Gavin said.



"We generally sow wheat or canola into paddocks spread with chicken litter, which is applied in March and April ahead of seeding.

"We have noticed an increase in worm and microbial activity in our soils since we began using chicken manure and our yields are

still increasing each season. The combination of chicken litter, no-till farming methods and better land management techniques means our soils are performing better each year."

The increasing costs of fertiliser and other farm inputs have affirmed Gavin's decision to use organic fertilisers such as chicken litter. In the first few years he spread litter at a rate of 2.5t/ha with 120 kg/ha of di-ammonium phosphate (DAP) but has now cut the DAP rate back to 60 to 80kg/ha; saving him almost \$25,000 a year in fertiliser cost.

"We still use traditional fertilisers but the amount has decreased significantly over the years. We are now using 30 to 40% less chemical fertilisers such as DAP than we were in the past."

Gavin says he would recommend other farmers use chicken litter to improve soil health and increase soil nutrition.

"From my experience, I would suggest farmers wanting to use chicken litter for the first time start by applying it to poorer paddocks to see how they perform," he said.



SPREADING CHICKEN LITTER ON THE SCHUSTER FARM.

"When it is priced competitively, chicken litter provides an opportunity to build soil nutrients more cheaply than using conventional fertilisers, but it depends on the relative prices of conventional fertilisers, the cost of the litter, spreading costs and how far it has to be transported."

To help with these cost calculations Rural Directions, has developed 'Poo Calc', a computer-based tool that is available on the Rural Directions website www.ruraldirections.com

"Chicken litter can be a fantastic soil improver for poor soils and we have some encouraging results from using it at rates of 10 to 20 t/ha to improve deep sandhill soils.

"Caution needs to be exercised because the amount of N applied at such high rates of litter might be detrimental to crops in a season with a dry finish, but I would recommend that growers with areas of poor soil give it a go to improve their soils and potentially increase yields."

Biosolids

Using biosolids (treated human waste) as an organic fertiliser can also improve soil health.

Many cultures have used, and still use, human waste as a fertiliser, but Australian farmers have only recently begun to explore the use of biosolids on broadacre crops with the aims of reducing nutrient costs and improving soil ecosystems.

"For growers close to sources of biosolids, this product can be more cost-effective than chicken litter," Tony said. "In SA, there is currently no charge for the material itself, so the only direct costs are for transport and spreading, although growers using the product have to comply with EPA requirements designed to address the risk of heavy metal accumulation in soils treated with biosolids."

"These requirements include soil testing to establish base levels of nutrients and heavy metals and limitations on the amount of biosolids that can be applied to soils over time.

There are also restrictions on where the



MIKE MC LAUGHLIN, CSIRO LAND AND WATER RESEARCH FELLOW.

product can be used in terms of soil type, slope, and proximity to water courses."

"Biosolids are generally easier to handle than chicken litter or pig bedding and can be spread with a standard belt spreader rather than a high-volume specialised manure spreader. The product is denser too, making it cheaper to transport than chicken litter or pig bedding, but transport cost is a significant issue and the economics are better for growers closer to Bolivar.

"However, the biosolids market is currently closed to new buyers," he said. "SA Water, the main supplier in SA, is limiting supply to growers who have used the product previously because the number of farmers already using the product is sufficient to deal with the volume produced."

According to Mike McLaughlin, Research Fellow for CSIRO Land and Water, biosolids are packed with important nutrients and a single application provides benefits to crops for several years.

"Biosolids are made from sludge, one of the two main waste streams generated in sewage treatment plants, where digesting and drying processes are used to remove water and pathogens from human waste and convert it to biosolids."

"This material contains important nutrients including N, P, sulphur (S), magnesium (Mg) and potassium (K), all of which can have beneficial effects on soil fertility and plant growth. Indeed,

BIOSOLIDS IMPROVING YIELDS AND SOIL HEALTH

Spreading biosolids on his cereal hay paddocks has improved soil health and crop yields for Mid North farmer Ashley Burgess.

Ashley, who farms at Gulnare, began using biosolids from SA Water's Bolivar treatment works north of Adelaide in 2006, and over the past seven years has noticed a considerable improvement in soil health and yields.

Ashley's agronomist, Peter Cousins recommended he apply biosolids in addition to traditional fertilisers to help increase soil nutrient levels and he began by top-dressing some of his poorer soil types with the material. He now spreads 750 to 800 tonnes of biosolids a year at a rate of 5 t/ha on a range of soil from red brown earth and clay to sands.

"The concentration of nitrogen (N) and phosphorus (P) in biosolids (1.5% and 1.0%) makes it a desirable soil enricher," Ashley said.

"We now have a good understanding of how this material works and its effect on our soils and get incredible results from applying double the normal rate to poorer areas where hay crops deplete nutrient levels."

When the biosolids is applied influences the level of benefit in the following year's crop, he said.

"We start carting from Bolivar in January each year and spread any time between March and May. A rain event at the start of the season helps considerably, because it carries nutrients from the biosolids into the soil."

Ashley was one of the first farmers in the mid north to use biosolids for broadacre farming.

"The horticultural industry has been using this material for many years, but it was only in the past 10 years that SA Water has allowed it to be used for agriculture. It is becoming more popular, especially as it's free," he said.

With no charge for the product, the only cost to use biosolids is the hire of a loader, transport from outer Adelaide and spreading costs.

"Using biosolids is very economical for us. We still use traditional fertilisers as well, but spreading biosolids has improved the health of our soils and increased our yields, making it a worthwhile exercise."

crop plants need adequate amounts of these nutrients to reach their yield potential.

"It also contains a wide range of trace elements such as copper, manganese, molybdenum and zinc that can have significant benefit in soils deficient in them.

"The concentration of N and P in biosolids is much less than in conventional fertilisers. Biosolids typically contain up to 6% N and 3% phosphate, but they can be applied at rates of five to 10 t/ha to meet all the crop's nutritional requirements."

Some of the N in biosolids is present in plant-available inorganic forms such as ammonium and nitrate but most is in organic forms that need to be mineralised before the N they contain can be taken up by plants, Mike said.

"Mineralisation is a microbial process in which organic N is converted into plant-available N, usually in the form of ammonium or nitrate. This process needs moist soil and occurs faster at higher temperatures.

"Unlike the N, most P in biosolids is in available inorganic forms, which can be significant, since many Australian soils are naturally low in P."

A National Biosolids Research Program conducted between 2000 and 2008 to assess the benefits of biosolids in agriculture ran 17 paddock trials in five States to explore crop responses to biosolids from different sources and the level of heavy-metal build-up where the material was applied.

"Wheat and canola rotations were set up in WA, SA and Victoria, there was a

triticale and oats rotation in Victoria, with wheat in NSW and a variety of crops including millet, maize, grain sorghum, forage sorghum and sugarcane in Queensland," Mike said.

"Many types of biosolids were used in the trials, which showed that biosolids applied at the N-limiting application rate – the rate calculated to exactly match the crop's N needs – could supply sufficient nutrients for crop growth.

"In general, biosolids applied at the N-limiting rate supplied sufficient nutrients for at least one to two annual cropping cycles without other inputs.

"Some of the trials encountered drought conditions and in those the biosolids reduced yield, with the combination of limited soil water and excess nutrition stimulating shoot growth and depleting soil moisture to restrict full grain filling, just as occurs when excess fertiliser N or other nutrient is applied."

There is plenty of potential for farmers to save money and increase trace elements in soils by using biosolids instead of chemical fertilisers, he suggests.

"Assuming N and P concentrations of 1.5% and 1.0% respectively, the value of N and P contained in the 300,000 dry tonnes of biosolids produced in Australia each year is more than \$20 million at current fertiliser nutrient costs.

"Individual growers using biosolids instead of conventional fertilisers can potentially make a significant difference to their business." 

ECO-SHELTER BEDDING ANOTHER OPTION

Spent bedding from straw-based eco-shelters, a popular form of pig housing on pork farms, is another potential source of nutrients and organic matter for broadacre cropping systems.

The growing sheds are cleaned out periodically and the spent bedding, comprising mainly decomposed straw and pig manure, partially composted in windrows for 12 to 24 months.

According to Rural Directions Agribusiness Consultant Tony Craddock, eco-shelter bedding is providing similar results to chicken litter as an alternative nutrient source for grain crops.

"The N, P, S and trace element content of eco-shelter bedding is similar to chicken litter on a dry weight basis but the bedding typically has twice the moisture content of chicken litter, so it needs to be applied at higher rates than chicken litter to achieve the nutrient input."

The performance of eco-shelter bedding in dryland cropping is still being assessed.

"With the assistance of Australian Pork Limited, Rural Directions conducted demonstration trials near Balaklava and Roseworthy in 2011 and at Palmer in 2012," Tony said.

"The Roseworthy and Palmer trials explored the need for starter rates of conventional fertiliser in the seed row when using eco-shelter bedding on soils with different P levels. The Balaklava trial explored whether or not high rates of eco-shelter bedding improved crop performance on sandhills.

"We found that, with 10 t/ha of eco-shelter bedding we didn't need conventional fertiliser in the seed row, but at 5 t/ha, some conventional fertiliser in the seed row was beneficial in soils with a low P background.

"Applying up to 20 t/ha of eco-shelter bedding on sandhills substantially improved yield and grain protein for two consecutive seasons, showing that eco-shelter bedding, like chicken litter, has the potential to improve poor soils.

"We didn't see any adverse effects due to excess N, but this could be a risk with high application rates in seasons that cut out early.

"Based on our initial findings, eco-shelter bedding is a valid alternative to chicken litter and biosolids. It has the potential to supply key plant nutrients to crops, and at high application rates has similar potential to improve poor soils."

Partially-composted bedding can be lumpy, Tony said, so this material, like chicken litter, requires specialised, high-volume manure spreaders for effective spreading.

"Farmers wanting to use this by-product would need to source it from nearby pork farms and, being a light, bulky product, it may prove expensive to transport long distances," he said.

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