Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

Protect
Grow
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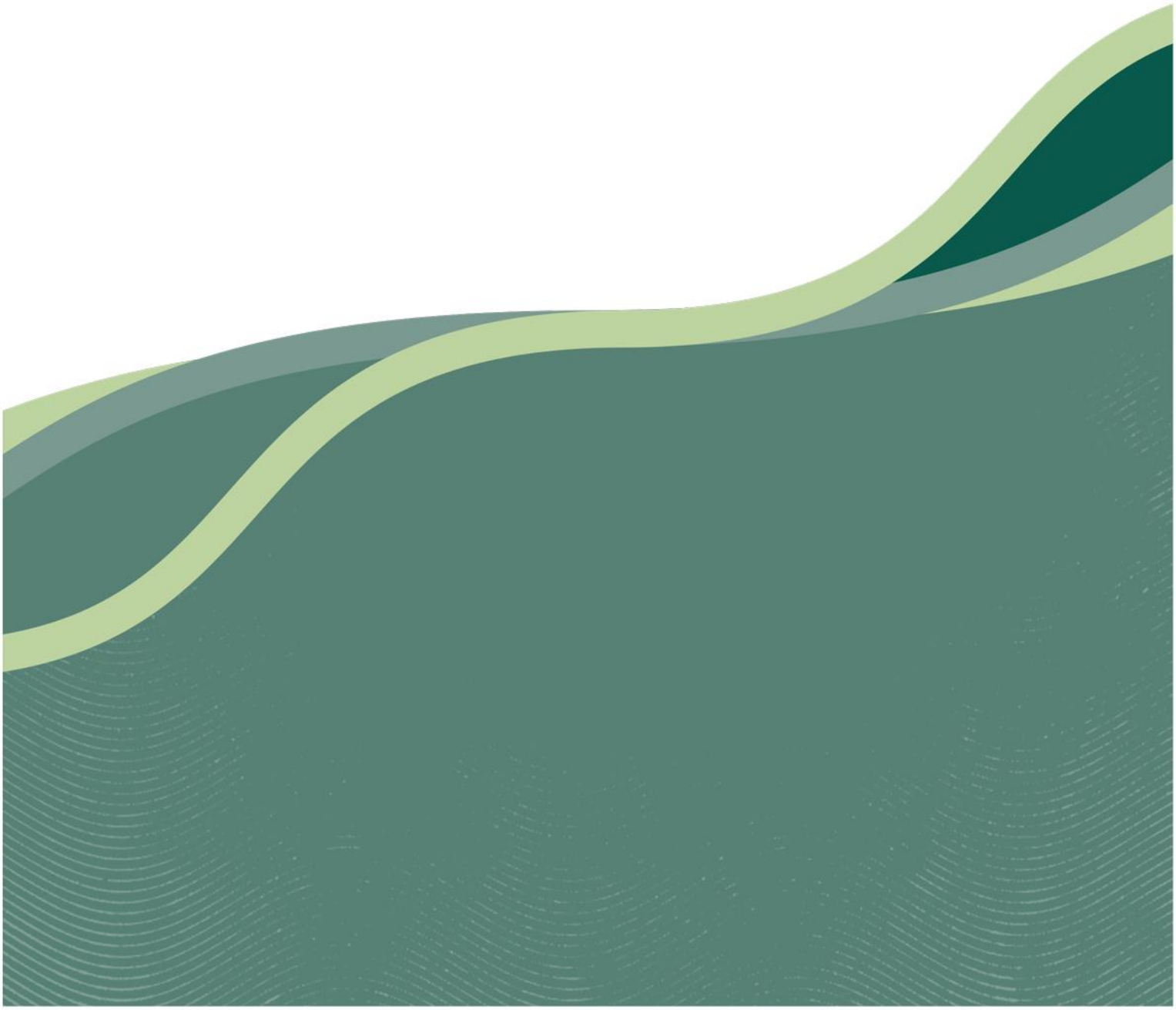
Solid Waste Management Plan

Example 3 - Broiler Farm



6 March 2024

Summary

A broiler farm in Bridgetown has 2,200 chickens for meat production per growth cycle. They are grown in a barn (160m^2 in size) at a stocking density of 14 birds per square metre. Wood shavings (depth of 5cm) are used as litter in the barn. The spent litter will be removed from the shed, aged, and then applied to land. A Solid Waste Management Plan is required for the application of the aged spent litter to land, to account for the nutrients.

Environmental Considerations

There are no waterways within 1km of the site and seasonal groundwater level is 3m at its highest for the whole site. There is an impermeable rocky area in the North-East of the property that will be avoided for solid waste application. A neighbouring vineyard is also situated on the East side of the property.

Spent litter was tested for heavy metals (specifically zinc) and fell within required agricultural limits. Testing of spent litter and soil samples will be conducted annually for heavy metal accumulation.

Nutrient Balance

Nutrients IN The spent litter waste generated is approximately 1.5t, per 1000 chickens, per growth cycle (McGahan, Wiedemann & Galvin, 2021). There are six growth cycles across a year.

Spent Litter Quantity [t /growth cycle] $= 1.5\ [t] \times \frac{bird\ quantity}{1000}$

$= 1.5\ [t] \times \frac{2\ 200}{1000}$

$= 3.3\ [t/growth\ cycle]$

Spent Litter Quantity [t /year] $= 3.3\ [t] \times 6\ [yearly\ growth\ cycles]$

$= 19.8\ [t/year]$

A more accurate assessment can be conducted with the knowledge of the spent litter density and depth. The following equation can be used (McGahan & Galvin, 2021):

Spent Litter Weight [t / year] $= \frac{number\ of\ birds}{stocking\ density\ [birds/m^2]} \times\ litter\ depth\ [m] \times yearly\ growth\ cycles \times density\ [t/m^3]$

Nutrient content – Spent litter (using wood shavings) has a phosphorous content of 1.3% and nitrogen content of 3.9% (see Appendix B).

Nutrients OUT

Spent litter is aged for one-month. Offsite laboratory testing is undertaken on a sample and shows that the nutrient content of the aged spent litter is 1.0% phosphorous and 3.1% nitrogen. The product is then spread.

Oaten hay (or winter cereal hay) is cut and removed, producing a yield of 6 t/ha with a nitrogen and phosphorous content of 20kg/t and 3kg/t, respectively (see Appendix A).

Determination of Spreading Rate

$$\textbf{Phosphorus spreading rate [t/ha]} = \frac{crop\ nutrient\ content\ [kg/t] \times crop\ yield\ [t/ha]}{waste\ nutrient\ content\ [\%] \times conversion\ factor\ [10]}$$

$$= \frac{3\ [kg/t] \times 6\ [t/ha]}{1.0\ [\%] \times 10}$$

$$= 1.8\ [t/ha]$$

Nitrogen volatilization in surface spreading methods accounts for around 20% of nitrogen losses (Tucker, 2018).

$$\textbf{Nitrogen spreading rate [t/ha]} = \frac{crop\ nutrient\ content\ [kg/t] \times crop\ yield\ [t/ha]}{waste\ nutrient\ content\ [\%] \times conversion\ factor\ (10) \times nitrogen\ volatilization}$$

$$= \frac{20\ [kg/t] \times 6\ [t/ha]}{3.1\ [\%] \times 10 \times 0.8}$$

$$= 4.84\ [t/ha]$$

The lowest spreading rate is phosphorus at 1.8t/ha and therefore this is the rate that will be employed for determining the minimum area required.

Determination of Minimum Area

Using the phosphorus spreading rate, the minimum area required is 11ha as calculated below:

$$\textbf{Minimum Area required [ha]} = \frac{total\ solids\ in\ waste\ [t]}{spreading\ rate\ [t/ha]}$$

$$= \frac{19.8\ [t]}{1.8\ [t/ha]}$$

$$= 11\ [ha]$$

Conclusion

The spreading rate is 1.8t/ha based on the limiting factor of phosphorus. Accounting for the quantity of waste produced the minimum area required for spreading is 11ha (Table 1). The property size of 40ha is therefore adequate for aged spent litter waste application on the broiler farm.

Table 1 Summary of solid waste generated per year (kg/year), spreading rate (t/ha) and minimum area required (ha).

	Nitrogen	Phosphorus
Spreading rate [t/ha]	4.84	1.8
Minimum area required [ha]	-	11

Records

The following records are to be kept and maintained for each year that manure is applied to the property.

- Duration of spent litter aging
- Laboratory results of composition post aging
- Area where spent litter waste has been applied
- Spreading rate
- Oaten hay yield
- Spent litter and soil heavy metal analysis

*Table 2 Log of waste information *maps and laboratory results are not attached as this is an example only.*

Date	Duration of aging	Area of application	Spreading rate	Resultant Yield (t/ha)	Other
1/12/21	1 month	See area specified on map attached	1.8t/ha	6	See laboratory results for composition and heavy metal analysis attached
5/12/22	1 month	See area specified on map attached	1.8t/ha	6	See laboratory results for composition and heavy metal analysis attached
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Important disclaimer

The Chief Executive Officer of the Department of Primary Industries and Regional Development and the State of Western Australia accept no liability whatsoever by reason of negligence or otherwise arising from the use or release of this information or any part of it.

References

McGahan, E., & Galvin, G. (2021) Planning and environment guideline for establishing meat chicken farms: Guide 2. AgriFutures. Retrieved from https://www.agrifutures.com.au/wp-content/uploads/2021/12/21-080.pdf

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Tucker, R. (2018). National environmental guidelines for indoor piggeries. *Australian Pork Limited: Canberra, ACT, Australia*.

Wiedemann, S. G. (2015). Litter reuse: an evidence-based guide to reusing litter. *Rural Industries Research and Development Corporation, Canberra, Australia*.

Appendix A

Table 2. – Nutrient Content of Various Crops. Source – APL, 2018.

Crop Nutrient Content (kg/t)			
Crop Type	**Nitrogen**	**Phosphorous**	**Potassium**
Irrigated pasture (cut)	20	3	15
Lucerne hay (cut)	31	3	25
Maize silage	22	3	20
Forage sorghum	22	3	24
Winter cereal hay	20	3	16
Grain barley	19	3	4
Grain wheat	19	4	5
Barley straw	7	0.7	24
Wheat straw	6	0.5	14
Grain triticale	19	4	6
Rice	14	3	4
Grain oats	15	3	4
Grain sorghum	20	3	3
Grain maize	20	3	4
Chickpea	40	4	4
Cowpea	30	4	20
Faba beans	40	4	12
Lupins	45	3	8
Navy beans	40	6	12
Pigeon peas	26	3	9
Canola	33	0.3	12
Cotton	20	4	8

Appendix B

Table 1. *Illustrating the average chemical properties (dry weight basis) of 123 Australian spent litter samples (McGahan et al., 2021).*

Element	**Straw (n = 28)**	**Sawdust (n = 28)**	**Wood shavings (n = 65)**	**Multi-batched (n=4)**
Moisture (%)	20 (15-25)	25 (20-29)	26 (21-31)	21 (21-22)
Total N (% db)	4.0 (2.0-5.3)	3.8 (2.8-5.9)	3.9 (2.8-5.5)	4.0 (3.6-4.3)
Total P (% db)	1.1 (0.7-1.8)	1.2 (0.8-1.5)	1.3 (0.7-1.7)	1.7 (1.3-2.0)
Potassium (% db)	2.2 (1.6-2.8)	1.8 (1.3-2.5)	1.9 (1.1-2.8)	2.4 (1.9-2.7)
Sulphur (% db)	0.63 (0.5-1.1)	0.54 (0.4-0.7)	0.51 (0.3-0.7)	0.58 (0.5-0.8)
Zinc (% db)	0.04 (0.02-0.05)	0.04 (0.03-0.05)	0.04 (0.03-0.04)	0.05 (0.04-0.07)
Copper (% db)	0.02 (0.01-0.02)	0.02 (0.01-0.02)	0.01 (0.01-0.03)	0.01 (0.01-0.02)
Manganese (% db)	0.05 (0.04-0.08)	0.04 (0.03-0.06)	0.05 (0.04-0.08)	0.07 (0.06-0.07)