Estimation of Nutrient Loading on Free Range Egg Farms in the Condamine Catchment

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ESTIMATION OF NUTRIENT LOADING ON FREE RANGE EGG FARMS IN THE CONDAMINE CATCHMENT

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EXECUTIVE SUMMARY

The egg industry is a key intensive livestock sector in the Condamine River Catchment NRM Region, with the majority of Queensland's egg production occurring in this area. Egg farms generate large volumes of nutrients from excreted manure. This manure is deposited in the shed and, for free range farms, across the area in which the birds range. It is not clear how much manure is deposited in free range areas, or whether the management of range areas is likely to pose a risk to water quality through nutrient losses.

This study aimed to provide an indication of nutrient loading rates in free range areas, by applying a mass balance modelling approach. Few quantitative studies have been conducted to investigate nutrient deposition in free range areas, and subsequently this study relied on a number of assumptions regarding the proportion of nutrients deposited in the range area, and the distribution of these nutrients. The uncertainty of modelling assumptions is discussed.

There are two contexts for comparison of nutrient deposition rates; i) comparison with sustainable application of nutrients for pasture or crop production, and ii) comparison with intensive industries such as beef cattle feedlots that are required to manage nutrients to minimise environmental risks.

When compared with nutrient applications for pasture or crops, the results show that shed sizes of 2500 birds or more are likely to deposit higher levels of nutrients than are required for plant production. While nutrient deposition rates around free range sheds may be higher than would be appropriate for crop or pasture utilisation, these results must be kept in context. Nutrient accumulation occurs across the landscape as a result the operation of several livestock industries in the Condamine Catchment. The magnitude of the nutrient accumulation and the location in the catchment need to be considered when determining risk. Free range egg farms housing 24,000 birds deposit a similar amount of nutrients within the free range area as the minimum size of regulated cattle feedlot (49 Standard Cattle Units). Even larger farms (up to 120,000 birds) deposit similar amounts of nutrients to small feedlots (up to 250 SCU) which are subject to only minimal environmental regulation.

A review of the location of free range egg farms within the catchment show that most are located in grain growing regions at considerable distance from open water ways. Some farms however are located on soils susceptible to leaching, which may have implications for nutrient losses to groundwater. Considering the loading rates noted in this report, regular sampling of potable ground water supplies would be recommended for farms housing more than 1000 birds. The lack of environmental guidelines for locating and managing free range farms presents some degree of concern for the catchment. This could be addressed by promoting sustainable practices for the development of free range farms throughout the industry.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 BACKGROUND

The egg industry is a key intensive livestock sector in the Condamine River Catchment NRM Region, with the majority of Queensland's egg production occurring in this area. Egg farms generate large volumes of nutrients from excreted manure. This manure is deposited in the shed and (for free range farms) across the area in which the birds range. It is important from the perspective of sustainable nutrient reuse on free range farms to know how much manure is deposited in the outdoor run area around the sheds and where it distributed. This knowledge will enable the egg industry and individual producers to better tailor the management of manure (and the nutrients it contains) deposited in free range areas.

A project completed in 2010 by FSA Consulting for Condamine Alliance, examined the distribution of nutrients on 14 free range poultry farms using Electro-Magnetic Induction Technology and is reported in Wiedemann & Zadow (2010a, 2010b). The study found that the nutrient distribution in free range areas showed a fairly consistent pattern of elevated nitrate and phosphorus close to the sheds (within approx. 20m). Some older farms had very high nutrient levels up to 50m from the sheds, though it was not clear if in some instances this was also driven by inherent soil fertility. These results were not surprising considering the behaviour of the birds and the obvious deposition of manure close to sheds and nearby trees.

In a free range egg production system a proportion of manure is deposited inside the shed (on litter or slats), and a proportion is deposited in the outdoor range. Manure deposited in the shed is typically removed at the end of the production cycle (about 60-80 weeks) and taken off-site or to cultivation areas for use as a fertiliser. Little research to date has investigated the percentage of manure that is deposited in the range area. Zeltner & Maurer (2009) have reviewed several European studies that investigated nutrient distribution in free range areas and reported that 15 to 25% of daily droppings are excreted in the run area. They also reviewed studies that had investigated high levels of nutrients and metals in highly frequented areas of a run (Menzi et al. 1997 and Berk et al. 2002 cited in Zeltner & Maurer 2009). A recent Australian Poultry CRC Project which studied the effect of enriching the range areas of free range laying hens found that only 9% of birds on free range farms use the range area. Factors found to influence the usage of the range area included weather (temperature, wind and rain), season, age, flock size, time of day shade and variety of overhead structures (Glatz & Bourke 2006).

The soil results from the EM survey indicated that nutrient levels could be very high in certain parts of a free range area, which suggests that free range egg farming could be similar to some other 'open lot' production systems such as beef and dairy lot-feeding (Wiedemann & Zadow 2010a). However, it is not clear what mass of nutrients are deposited in the free range area, how this mass of nutrients is distributed in the range area and what this equates to in terms of nutrient losses in the runoff from free range areas.

As nutrient excretion rates have never been measured, this study aims to use the best available research to:

1) Estimate manure excretion rates from different sized flocks of birds.
2) Estimate the proportion of manure that is deposited in the range area.
3) Establish the different zones of nutrient distribution in a range area and estimate the mass of nutrients (N, P, K) that may be deposited in each zone.

4) Compare the nutrient loading of free range areas to beef feedlot best practice guidelines to provide an indicator of expected nutrient losses in runoff from a range area and what management practices may be applicable for free range systems with different bird densities.

This was achieved by:

- Estimating the total manure production of different sized flocks
- Expanding on the nutrient distribution results obtained from the EM surveys of free range farms in the Condamine Catchment (Wiedemann & Zadow 2010a),
- Estimating the proportion of nutrients deposited within the outdoor range area in a normal egg production cycle from different sized production systems.

2 METHODOLOGY

2.1 ESTIMATING NUTRIENTS DEPOSITED IN THE OUTDOOR RANGE AREA

To best represent the range in current and potential sized free range egg farms in the Condamine Catchment several scenarios of different sized sheds (Table 1) were modelled. Shed sizes were determined using a starting bird density of 0.1 birds/m^2.

TABLE 1. FREE RANGE EGG FARM MANURE PRODUCTION SCENARIOS

Production Scenario	Number of birds / shed	Shed Dimensions (length x width)	Shed floor area (m^2)
S1	500	10 m x 5 m	50
S2	1000	12.5 m x 8 m	100
S3	2500	25 m x 10 m	250
S4	5000	50 m x 10 m	500
S5	10,000	83 m x 12 m	996
S6	50,000	250 m x 20 m	5,000

Annual manure production and the mass of N, P & K produced in each production scenario was estimated using Egg-Bal, an in-house mass balance spreadsheet model. Pullets entered the shed at 16 weeks of age, and exited at 80 weeks giving a 64 week production cycle. The nutrient content of the manure produced was estimated to be 0.78 kg of N / bird / year, 0.07 kg P/ bird / year and 0.09 kg K / bird / year.

The total mass of nutrients (N, P & K) produced in each production scenario is detailed inTable 2.

TABLE 2. TOTAL NUTRIENT PRODUCTION OF LAYER PRODUCTION SCENARIOS (1 SHED)

Production Scenario	No birds / shed	Total Manure Production (kg/year)		
		N	P	K
S1	500	391	33	47
S2	1000	782	67	94
S3	2500	1955	166	234
S4	5000	3910	333	469
S5	10000	7819	665	938
S6	50000	39097	3326	4688

The percentage of manure deposited in layer free range areas was estimated to be 9-25% of total manure production from the literature reviewed. As the uncertainty of this number is high, a range of deposition percentages were used in this analysis (10%, 20% and 30%). A 20% nitrogen volatilisation rate in the range area was used for calculating the percentage of nitrogen deposited as manure.

2.2 NUTRIENT DISTRIBUTION WITHIN FREE RANGE AREAS

Previous work employing the use of EM surveys has shown that nutrients are not distributed evenly within a range area (Wiedemann & Zadow 2010a, Wiedemann & Zadow 2010b). Different zones of nutrient concentrations were identified, with the highest concentration of nutrients found closest to the shed and under shade structures (e.g. trees) where the birds spend most of their time. From these areas of high use, there is a gradual decline in the concentration of nutrients away from the sheds. Several of the free range farms surveyed were reviewed to determine the approximate distance from the shed where these different zones of nutrient concentration occurred. The farms reviewed all had a strong correlation between the EM survey results (apparent electrical conductivity EC_a) and the distribution of nitrogen and phosphorus. An example nutrient distribution map is shown in Figure 1. The average distance between nutrient concentration zones was identified for several farms and the average results indicated that Zone 1 (closest to the shed) was ~9 m, Zone 2 is ~9 to ~23 m and Zone 3 is ~23 m plus.

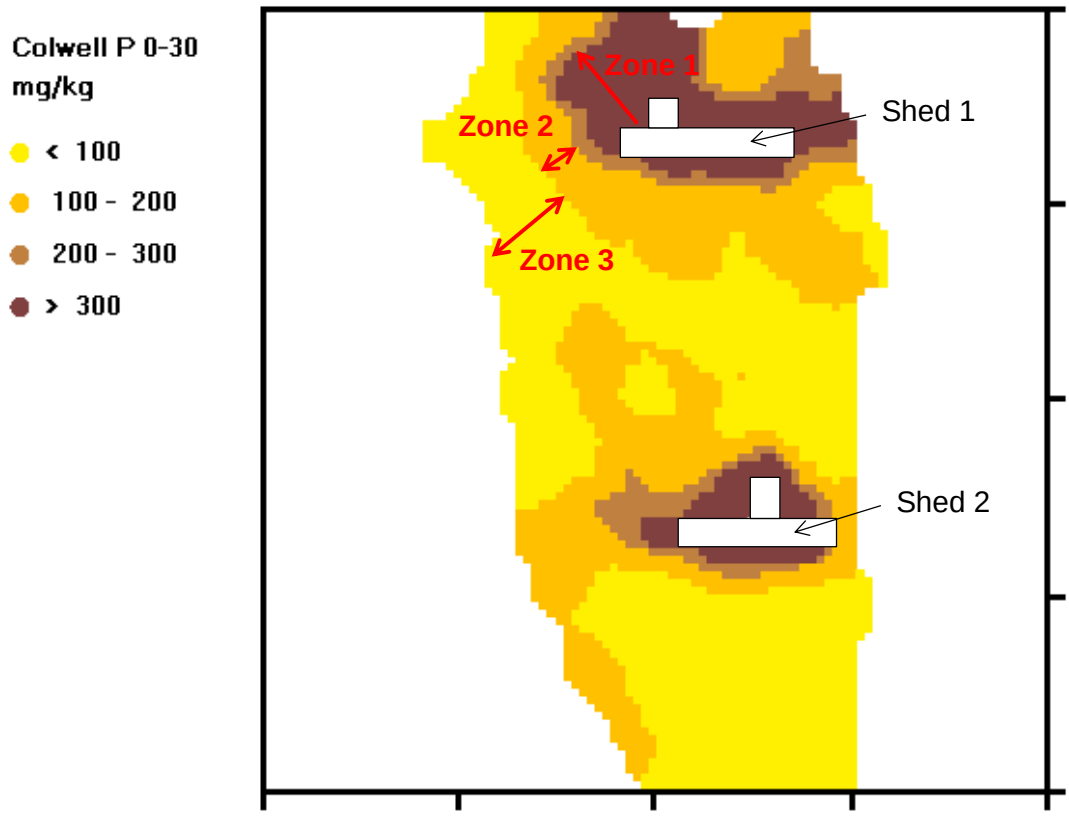

FIGURE 1. EXAMPLE NUTRIENT DISTRIBUTION MAP OF FREE RANGE AREA

The nutrient zones modelled for each sized farm are detailed in Table 3.

TABLE 3. NUTRIENT ZONES IN MODELLED FREE RANGE AREAS

Zone	Distance from shed	Percentage of nutrients deposited in range area
1	0 - 10 m	70%
2	10 - 25 m	20%
3	25 - 100 m	10%

Using a 'standard' range design for each production scenario, a range area (m^2) for each nutrient zone was calculated based on the shed dimensions in Table 1 and the distances from shed in Table 3. The 'standard range' design was based on the birds having access to all sides of the shed to a maximum extent of 100 m. An example range for production scenario 3 (2500 birds) is shown in Figure 2. The range area for each nutrient zone for the 6 scenarios is detailed in Table 4. The total nutrients deposited in the range areas is not known, but was assumed to vary from 10% - 30%, with a mean of 20% of total manure production. This was then divided into each sized range area for the three nutrient zones (Table 4) according to the preferential deposition percentages in Table 3.

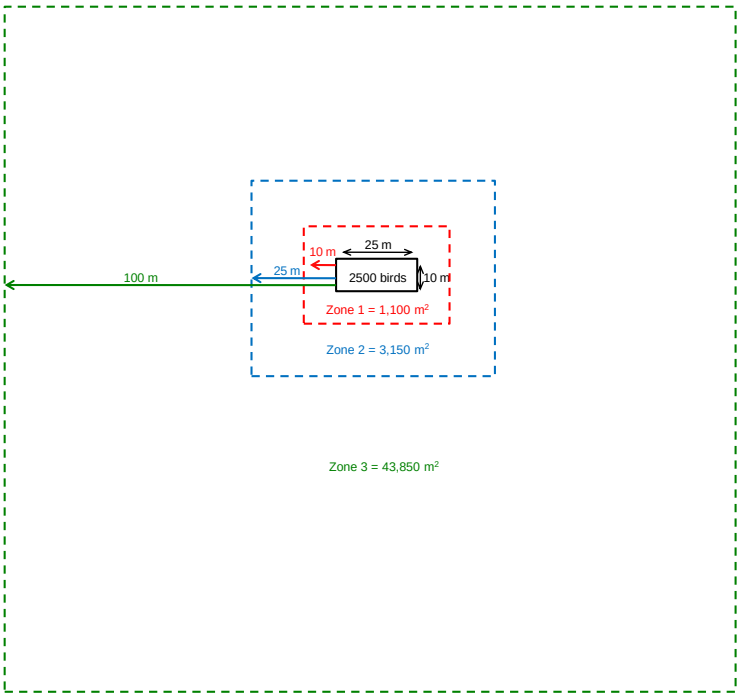

FIGURE 2. EXAMPLE RANGE DESIGN FOR EACH NUTRIENT ZONE (S3 – 2500 BIRDS)

TABLE 4. NUTRIENT ZONE RANGE AREAS

Production Scenario	Zone 1 (10 m) range area (m^2)	Zone 2 (10 – 25 m) range area (m^2)	Zone 3 (25 – 100 m) range area (m^2)
S1 = 500 birds	700	2550	40450
S2 = 1,000 birds	810	2715	41385
S3 = 2,500 birds	1100	3150	43850
S4 = 5,000 birds	1600	3900	48100
S5 = 10,000 birds	2307	4960	54107
S6 = 50,000 birds	5800	10200	83800

3 RESULTS

3.1 NUTRIENT DEPOSITION IN FREE RANGE AREAS

Results are presented using the assumed mean deposition rate of 20%, ± 10%. The mass of N, P and K in the manure deposited in the free range area of each sized shed is shown in Table 5.

TABLE 5. NUTRIENT DEPOSITION IN FREE RANGE AREAS (20% ± 10%)

Production Scenario	No birds / shed	Total Manure in Range Area (kg/year)		
		N*	P	K
S1	500	63 ± 31	7 ± 3	9 ± 5
S2	1000	125 ± 63	13 ± 7	19 ± 9
S3	2500	313 ± 156	33 ± 17	47 ± 23
S4	5000	626 ± 313	67 ± 33	94 ± 47
S5	10000	1251 ± 626	133 ± 67	188 ± 94
S6	50000	6255 ± 3128	665 ± 333	938 ± 469

*Includes a 20% N volatilisation loss from the range area.

3.2 NUTRIENT DISTRIBUTION IN FREE RANGE AREAS

Manure deposition rates were distributed into three zones within the range area (70% of deposited nutrients in zone 1, 20% in zone 2 and 10% in zone 3). The nutrient deposition rate (kg/ha) for each farm size under the three nutrient deposition scenarios is shown below for production scenarios S1 (500 birds), S3 (2500 birds), S5 (10,000 birds) and S6 (50,000 birds).

3.2.1 PRODUCTION SCENARIO 1 – 500 BIRDS

TABLE 6. NUTRIENT LOADING IN THE FREE RANGE AREA FOR S1 (500 BIRDS)

Distance from shed	Annual nutrient loading in range area (20% ± 10%)		
	N (kg/ha/yr)	P (kg/ha/yr)	K (kg/ha/yr)
<10m	626 ± 313	67 ± 33	94 ± 47
10 – 20m	179 ± 89	19 ± 10	27 ± 13
20 – 100m	89 ± 45	10 ± 5	13 ± 7

3.2.2 PRODUCTION SCENARIO 3 – 2,500 BIRDS

TABLE 7. NUTRIENT LOADING IN THE FREE RANGE AREA FOR S3 (2,500 BIRDS)

Distance from shed	Annual nutrient loading in range area (20% ± 10%)		
	N (kg/ha/yr)	P (kg/ha/yr)	K (kg/ha/yr)
<10m	1990 ± 995	212 ± 106	298 ± 149
10 – 20m	569 ± 284	60 ± 30	85 ± 43
20 – 100m	284 ± 142	30 ± 15	43 ± 21

3.2.3 PRODUCTION SCENARIO 5 – 10,000 BIRDS

TABLE 8. NUTRIENT LOADING IN THE FREE RANGE AREA FOR S5 (10,000 BIRDS)

	Annual nutrient loading in range area (20% ± 10%)		
Distance from shed	N (kg/ha/yr)	P (kg/ha/yr)	K (kg/ha/yr)
<10m	3797 ± 1898	404 ± 202	569 ± 285
10 – 20m	1085 ± 542	115 ± 58	163 ± 81
20 – 100m	542 ± 271	58 ± 29	81 ± 41

3.2.4 PRODUCTION SCENARIO 6 – 50,000 BIRDS

TABLE 9. NUTRIENT LOADING IN THE FREE RANGE AREA FOR S6 (50,000 BIRDS)

	Annual nutrient loading in range area (20% ± 10%)		
Distance from shed	N (kg/ha/yr)	P (kg/ha/yr)	K (kg/ha/yr)
<10m	7550 ± 3775	803 ± 401	1131 ± 566
10 – 20m	2157 ± 1079	229 ± 115	323 ± 162
20 – 100m	1079 ± 539	115 ± 57	162 ± 81

4 DISCUSSION

4.1 NUTRIENT LOADING IN POULTRY FREE RANGE AREAS

There are two contexts for comparison of nutrient deposition rates; i) comparison with sustainable application of nutrients for pasture or crop production, and ii) comparison with intensive industries such as beef cattle feedlots that are required to manage nutrients to minimise environmental risks.

4.1.1 COMPARISON WITH SUSTAINABLE APPLICATION FOR PASTURE OR CROP GROWTH

Sustainable application rates for manure or fertiliser applications to pastures or crops need to be calculated by determining the nutrient demand of the crop being established, existing soil nutrient status and the composition of the manure or fertiliser being applied. For crops this is determined with the following general formula:

Nutrient requirement = Crop uptake + expected losses + soil storage

Two paddock nutrient balances for a highly productive grazed pasture a low and high yielding wheat crop are described below in order to compare sustainable fertiliser and manure application rates to nutrient deposition rates in the modelled free range areas.

Example 1 – highly productive grazed pasture

Capital nutrient input rates to improve baseline soil nutrient levels for highly productive grazed pastures would be in the order of 27 kg/ha/yr of P. This rate would be equivalent to:

- 300 kg/ha/yr of single super phosphate
- 2-2.5 t/ha/yr of layer manure (at 50% moisture).

Once baseline nutrient levels have improved (i.e. soil phosphorus > 20 mg/kg of Colwell P (2-3 years of high P applications), maintenance P application levels would be more in the order of 10 kg/ha/yr, which would be the equivalent to:

- 110 kg/ha/yr of single super phosphate
- 0.8 t/ha/yr of layer manure (at 50% moisture).

Maximum levels of nitrogen that are likely to be applied to pastures would be in the order of 300 kg/ha/yr of N (this would be for highly productive, irrigated pastures only). This is equivalent to:

- 650 kg/ha/yr of urea
- 10.5 t / ha layer manure (at 50% moisture).

Table 10 to Table 13 compares the maximum levels of N and P that would be applied as fertilisers or manure to a productive pasture to the levels that are deposited in the free range areas for selected shed scenarios.

TABLE 10. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S1 (500 BIRDS) FOR PRODUCTIVE PASTURE

	$N_{(max)}$	$P_{(capital)}$	$P_{(maintenance)}$
Rates applied as fertiliser (kg/ha/yr)	300	27	10
Zone 1 (>10 m)	626 (2x)	67 (2.5x)	67 (6.7x)
Zone 2 (10-20 m)	179	19	19 (1.9x)
Zone 3 (20-100 m)	89	10	10

TABLE 11. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S3 (2,500 BIRDS) FOR PRODUCTIVE PASTURE

	$N_{(max)}$	$P_{(capital)}$	$P_{(maintenance)}$
Rates applied as fertiliser (kg/ha/yr)	300	27	10
Zone 1 (>10 m)	1190 (4x)	212 (7.9x)	212 (21x)
Zone 2 (10-20 m)	569 (1.9x)	60 (2.2x)	60 (6x)
Zone 3 (20-100 m)	284	30	30 (3x)

TABLE 12. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S5 (10,000 BIRDS) FOR PRODUCTIVE PASTURE

	$N_{(max)}$	$P_{(capital)}$	$P_{(maintenance)}$
Rates applied as fertiliser (kg/ha/yr)	300	27	10
Zone 1 (>10 m)	3797 (12.6x)	404 (15x)	404 (40x)
Zone 2 (10-20 m)	1085 (3.6x)	115 (4.3x)	115 (11.5x)
Zone 3 (20-100 m)	542 (1.8x)	58 (2.1x)	58 (5.8x)

TABLE 13. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S5 (50,000 BIRDS) FOR PRODUCTIVE PASTURE

	$N_{(max)}$	$P_{(capital)}$	$P_{(maintenance)}$
Rates applied as fertiliser (kg/ha/yr)	300	27	10
Zone 1 (>10 m)	7550 (25x)	803 (29.7x)	803 (80x)
Zone 2 (10-20 m)	2157 (7x)	229 (8.5x)	229 (23x)
Zone 3 (20-100 m)	1079 (3.6x)	115 (4.3x)	115 (11.5x)

The comparison indicates that for all shed sizes, nutrient loading in zone 1, close to the shed is well above typical application rates for fertiliser onto pastures. Nutrient levels in the second and third zones (i.e. most of the range area) tend to be greater than capital applications of phosphorus for shed sizes above 2500 birds.

Example 2 – low (2.5 t/ha) and high (5t/ha) yielding wheat crop

In this case, nutrient application rates would be based upon crop requirements which would equate to 44 kg/ha of N and 9 kg/ha of P for a low yielding wheat crop (2.5t/ha). This nutrient requirement could be met by the application of:

- 50 kg/ha/yr of MAP and 90 kg/ha/yr of Urea; or
- 1 t/ha/yr of layer manure + 60 kg/ha/yr of Urea.

Nutrient application rates for a high yielding wheat crop (5t/ha) would equate to 88 kg/ha of N and 18 kg/ha of P. This nutrient requirement could be met by the application of:

- 80 kg/ha/yr of MAP and 175 kg/ha/yr of Urea; or
- 1.5 t/ha/yr of layer manure + 102 kg/ha/yr of Urea

Table 14 to Table 17 compares the maximum levels of N and P that would be applied as fertilisers or manure to a low (2.5 t/ha) and high (5 t/ha) wheat crop to the levels that are deposited in the free range areas for selected shed scenarios. It was assumed that crops could not be grown in zone 1 because of proximity to the shed.

TABLE 14. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S1 (500 BIRDS) FOR LOW AND HIGH YIELDING WHEAT CROP

	$N_{(req)}$	$P_{(req)}$
Rates applied as fertiliser (kg/ha/yr) for 2.5t/ha wheat crop	44	9
Rates applied as fertiliser (kg/ha/yr) for 5t/ha wheat crop	88	18
Zone 2 (10-20 m)	179 (2-4x)	19 (0-2x)
Zone 3 (20-100 m)	89 (0-2x)	10

TABLE 15. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S3 (2,500 BIRDS) FOR LOW AND HIGH YIELDING WHEAT CROP

	$N_{(req)}$	$P_{(req)}$
Rates applied as fertiliser (kg/ha/yr) for 2.5t/ha wheat crop	44	9
Rates applied as fertiliser (kg/ha/yr) for 5t/ha wheat crop	88	18
Zone 2 (10-20 m)	569 (6.5-13x)	60 (3.3-6.7x)
Zone 3 (20-100 m)	284 (3.2-6.5x)	30 (1.7-3.3x)

TABLE 16. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S5 (10,000 BIRDS) FOR LOW AND HIGH YIELDING WHEAT CROP

	$N_{(req)}$	$P_{(req)}$
Rates applied as fertiliser (kg/ha/yr) for 2.5t/ha wheat crop	44	9
Rates applied as fertiliser (kg/ha/yr) for 5t/ha wheat crop	88	18
Zone 2 (10-20 m)	1085 (12.3-24.6x)	115 (6.3-12.8x)
Zone 3 (20-100 m)	542 (6.1-12.3)	58 (3.2-6.4x)

TABLE 17. COMPARISON OF DEPOSITION RATES IN FREE RANGE AREA OF S6 (50,000 BIRDS) FOR LOW AND HIGH YIELDING WHEAT CROP

	$N_{(req)}$	$P_{(req)}$
Rates applied as fertiliser (kg/ha/yr) for 2.5t/ha wheat crop	44	9
Rates applied as fertiliser (kg/ha/yr) for 5t/ha wheat crop	88	18
Zone 2 (10-20 m)	2157 (24.5-49)	229 (12.7-25.4x)
Zone 3 (20-100 m)	1079 (12.3-24.5)	115 (6.4-12.8x)

The comparison indicates that nutrient deposition rates tend to be greater than crop nutrient requirements for all shed sizes.

The layout of the sheds and range areas will also have an effect on the concentration of nutrients in the range area, and where they are distributed (discussed further in section 4.2). For all of these reasons, the results should be treated cautiously.

It is also important to note that the results presented in this study are subject to a high degree of uncertainty due to the uncertainty of the assumptions regarding; i) the percentage of nutrients deposited in the range area, and ii) the distribution of these nutrients between each zone in the range area.

This noted, even very conservative estimates of manure deposition (10% of excreted manure deposited in the range area) still result in higher nutrient deposition rates than would be required for cropping or pasture production in sheds housing more than 2500 birds. This is supported by the findings by (Wiedemann & Zadow 2010a), who showed that nutrient levels in soils within free range areas were commonly well in excess of pasture or crop requirements.

It should be noted that crop off-take rates could be increased if irrigated hay crops or pasture could be harvested from range areas. Scenarios were not run to investigate these crops because of the unlikelihood of these crops being grown on free range egg farms in the Condamine Catchment. Nutrient removal rates from high yielding hay crops may be two-three times higher than the high yielding grain crop used in the example above.

4.1.2 COMPARISON TO EXISTING FEEDLOT GUIDELINES

As section 4.1.1 demonstrates, it is highly likely that free range sheds with greater than 500 birds are likely to have range areas that are overloaded with nutrients. In most cases growing and cut and carting pasture or crops in free range areas is not an option for most farms due to the design of the free range farms being inaccessible for machinery and the interruption it would cause to production unless sheds could be shifted. However it is important to put in perspective the real environmental concern of overloading free range areas in terms nutrient losses into groundwater or surface waters.

To date, no work has been done in Australia to measure the losses of nutrients via these pathways from poultry free range areas and there is currently no best practice manual that covers nutrient management on free range poultry farms in Australia. In a first attempt to

quantify the risk of nutrient losses from free range areas we compared our results to the environmental standards for cattle feedlots in Queensland (Skerman 2000).

There are several main construction features of cattle feedlots that are employed to better manage manure and reduce the risk of uncontrolled nutrient losses. These include constructing a compacted pad to; a) minimise the risk of nutrients leaching through the soil profile into groundwater, and b) provide a surface that allows regular manure removal from the pad. As a compacted surface generates nutrient enriched stormwater runoff, this runoff (effluent) requires management to ensure it does not cause environmental harm. Typically, feedlots use either dispersal (for small feedlots) or effluent containment ponds (larger feedlots) to manage effluent. Effluent management via dispersal or irrigation relies on matching nutrient application rates to pasture or crop requirements and ensuring effluent does not flow into groundwater or surface water sources.

To enable the comparison of nutrient deposition in poultry free range areas to nutrient deposition in cattle feedlots, equivalent nutrient excretion rates between poultry and feedlot cattle (i.e. per Standard Cattle Unit – SCU) were determined. . This was done by estimating the manure production of 1 SCU using BeefBAL version 9.1 (QPIF 2004) and comparing the results to the manure production of 1 bird place (i.e. one bird over one year). assuming that 20% of manure is deposited in the range area (Table 18). For phosphorus deposition, 1 SCU = 650 bird places and for nitrogen deposition, 1 SCU = 490 bird places.

TABLE 18. COMPARISON OF MANURE DEPOSITION IN RANGE AREA TO 1 SCU

Parameter	Cattle Feedlot (kg / SCU / yr)	Manure production (kg / bird / yr)	Manure deposited in range area (20% of excreted – kg / bird / yr)	Bird places / SCU
Total Solids	810			
Volatile Solids	569			
Ash	241			
Nitrogen*	75.9	0.78	0.156	490
Phosphorus	9.1	0.07	0.014	650
Potassium	34.4	0.09	0.018	1910

Note: nitrogen losses from pad and range area have not been estimated for this comparison.

Most commercial feedlots operate at 12 to 20 m^2 per SCU. If we use 15 m^2 per SCU, this equates to 43 birds/m^2 or 430,000 birds/ha in terms of phosphorus deposition rates or 324,667 birds/ha in terms of nitrogen deposition.

There are four classes of feedlots in Queensland which have varying design, construction and operational requirements depending on the number of SCU the feedlot is designed for and site characteristics. In terms of nutrient management requirements:

- Feedlots in Queensland with less than 49 SCU do not need to be licensed.
- Feedlots less than 250 SCU (class 4) do not require a compacted pad.

Effluent management by paddock dispersal runoff may be suitable for feedlots less than 500 SCU provided suitable dispersal can be achieved. Effluent dispersal is not recommended for feedlots greater than 500 SCU.

In terms of bird places a 49 SCU feedlot equates to a free range area stocked with 24,010 bird places if we use nitrogen as an indicator of nutrient deposition, and 31,850 bird places if we use phosphorus. This suggests that poultry farms with bird numbers lower than 23,800 bird places / shed are likely to generate nutrient excretion levels that would not be subject to regulation in the feedlot industry.

The nutrient excretion from a 250 SCU feedlot is equivalent to 121,750 bird places (based on nitrogen excretion). At this level, feedlots are required to construct impermeable pads and manage effluent to reduce the risk of environmental harm. Considering this, it may be necessary for larger free range farms to investigate methods that ensure nutrient losses do not result in environmental harm. This may require construction of compacted pads and management of runoff from the free range area. Dispersal of effluent from range areas may be appropriate for farms up to 250,000 bird places (roughly equivalent to a 500 SCU feedlot). It should be noted that these numbers are based on a 20% excretion rate within the range area. The deposition rate per square metre is also dependent on the assumptions regarding the type of range area (unrestricted access 360° from shed). Where range areas are restricted (to one side of the shed, for example) the densities would double. Hence, farms with as few as 10,000 birds per shed in limited range areas may warrant further investigation of nutrient deposition rates.

4.2 OTHER FREE RANGE SCENARIOS

Poultry sheds and range areas can have numerous layouts. The size of the range area and the overlapping of range areas of adjacent sheds can have a big influence on the nutrient loading and distribution of range areas. In our modelling, we have assumed that each shed has a range area that extends in all directions from the shed to a maximum of 100 m. It should be noted that some birds are known to range beyond this distance, though manure deposition is probably minimal. The size of a free range area with these parameters may also not be realistic for farm management. For example, a 2500 bird shed each shed would require a range area of 4.8 ha. For a farm with 8 sheds, this equates to 38.5 ha, with each shed at least 200m apart. This may not be practical for the daily management of a commercial poultry farm in terms of feed delivery, egg collection and the availability of suitable land.

Some alternative shed and range area layouts employed by the industry are illustrated in Figure 3 but many combinations are possible. All of these arrangements would result in different nutrient concentrations in the range areas. For example, shed layout B would have twice the nutrient loading of range area A. Restricting the area in zone 3 (shed layout C) in several directions would also increase the nutrient loading in zone 3. Situating sheds close together will result in range areas overlapping, increasing nutrient loading in zone 3 (shed layout F) or eliminating a zone 3 altogether (shed layout E).

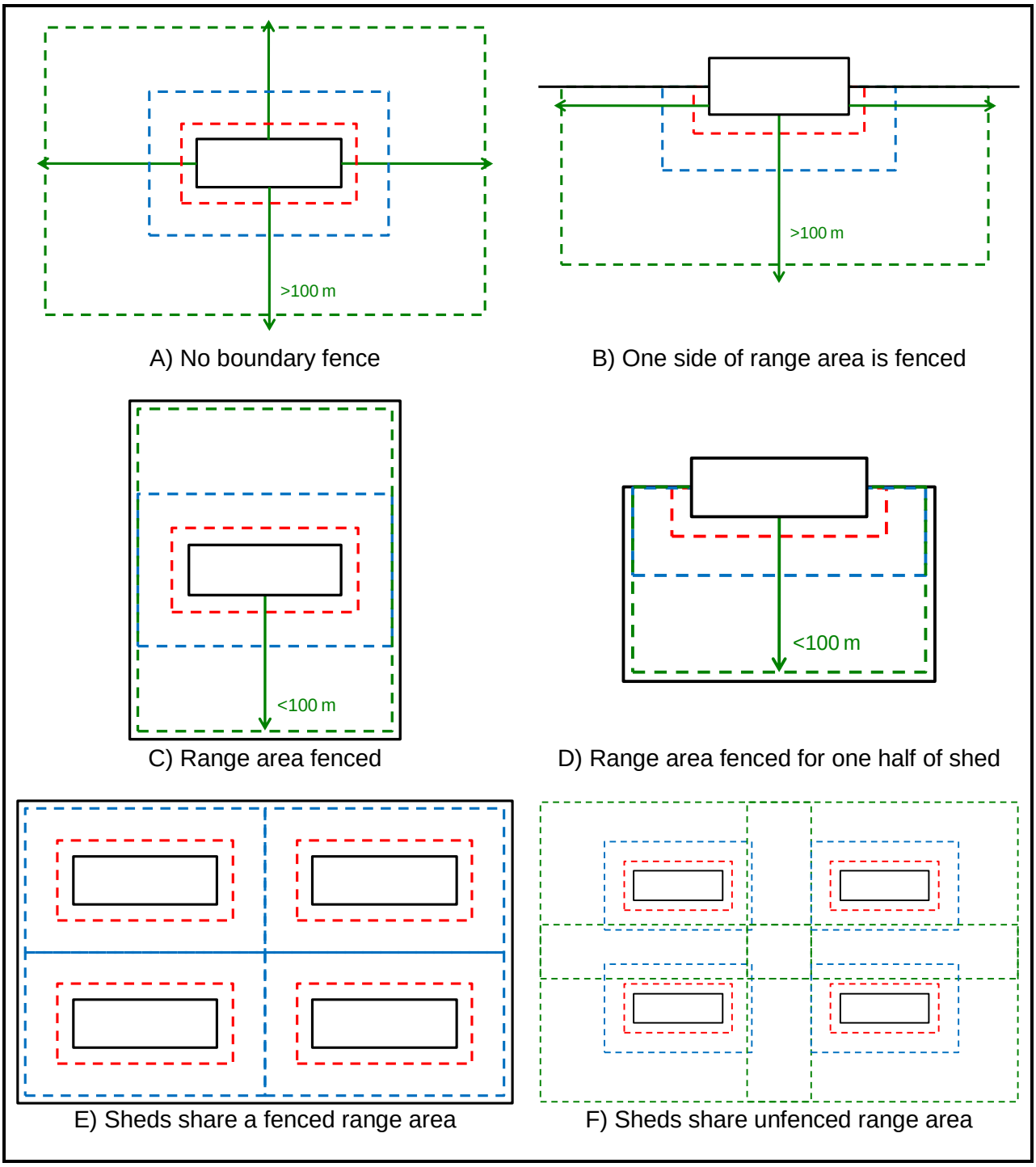

FIGURE 3. EXAMPLE RANGE AREA AND SHED CONFIGURATIONS

5 CONCLUSIONS AND RECOMMENDATIONS

Because of the lack of research relating to nutrient deposition rates in poultry free range areas, a large number of assumptions were required in order to model the results presented in this study. Modelling assumptions were based on mass balance theory to determine the mass of excreted nutrients from the hens, and then a number of assumptions regarding the deposition rates within free range areas. The deposition assumptions are subject to a high degree of uncertainty (which has been noted in the report). For this reason, the results should be treated cautiously.

There are two contexts for comparison of nutrient deposition rates; i) comparison with sustainable application of nutrients for pasture or crop production, and ii) comparison with intensive industries such as beef cattle feedlots that are required to manage nutrients to minimise environmental risks.

When compared with nutrient applications for pasture or crops, the results show that shed sizes of 2500 birds or more are likely to deposit higher levels of nutrients than are required. High nutrient deposition rates may increase the risk of nutrient losses. While nutrient deposition rates around free range sheds may be higher than would be appropriate for crop or pasture utilisation, these results must be kept in context. It is accepted, for example, that nutrient accumulation will occur in many agricultural systems. Grazing cattle or sheep will result in increased nutrient densities around livestock camps, stock yards and feeding areas. It is important to note that it is considered acceptable to feed up to 49 cattle (SCU) without any form of environmental regulation. It is also possible to operate small feedlots (<250 SCU) with minimal environmental controls. For feedlots between 49-250 SCU, the main criteria to be considered is the likely risk of nutrient losses to sensitive water sources. Provided a feedlot is located a suitable distance from an open water body and is not located on ground subject to excessive leaching into potable groundwater, the risk of environmental harm may be deemed to be relatively low. A similar case could be established for free range poultry operations of <100,000 birds that provide adequate range areas and are located in low risk areas.

Because of the uneven distribution of nutrients in range areas (high loading close to the shed), it may be possible for risks to be lowered by restricting the risk of loss from this area. For shed sizes of greater than 10,000 birds, it may be appropriate to construct a compacted pad and controlled drainage area. This would be dependent on the risk of nutrient contamination to groundwater and surface water however. Clearly, the first step to sound environmental management of free range farms should relate to locating these facilities in areas where the threat to surface and groundwater contamination is low.

Most established free range farms in the Condamine Catchment are located in grain growing regions and are often >1 km from an open water source. This means the risk of harm to water quality from nutrient losses is low. However, some farms are located on free draining soils that may allow rapid leaching of nutrients (particularly nitrogen) into groundwater. Considering the loading rates noted in this report, regular sampling of potable ground water supplies would be recommended for farms housing more than 1000 birds.

This report has identified that nutrient loading from free range farms can be high, particularly from larger facilities. The lack of environmental guidelines for development and

management of these facilities presents some degree of concern for the catchment. It would be beneficial for the industry and the catchment to address this issue to ensure future expansion of the industry is done in a way that sustains the overall health of the catchment. This could be achieved by providing general environmental information for the sustainable development of free range farms in the catchment.

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