

Meat Chicken Technical Environmental Note 2

Manure Production and Spent Litter Composition

Estimating Manure Production

General Principle

The quantity of manure that meat chickens excrete depends on feed intake and diet digestibility. The amount of total solids (dry matter) excreted can be estimated from the dry matter digestibility of the diet.

The amount of any nutrient excreted can be calculated from mass balance principles:

$$\text{Amount Fed} - \text{Amount Retained (Liveweight gain)} = \text{Amount Excreted}$$

Using these mass balance principles, meat chickens excrete or waste approximately 55% of the nitrogen, 70% of the phosphorus and 80% of the potassium they are offered in the feed. The amount of spilt feed can significantly affect the total amount of solids and nutrients remaining in the spent litter.

Feed Digestibility

The digestibility of a whole diet can be estimated from the digestibility of each individual feed ingredient and the amount of each ingredient in the diet. Meat chicken diets generally have a dry matter digestibility of about 85–90%. Thus, meat chickens only excrete about 10–15% of the dry matter they consume. The feed conversion of meat chickens of 2 kg liveweight is typically about 1.8:1 (for every 1.8 kg of feed consumed there is 1 kg of liveweight gain).

Estimated Manure Production

Meat chickens consume approximately 2.7 kg of dry matter up to 35 days of age (typical first thin-out) and 5.0 kg of dry matter up to 49 days of age (typical final clean-out). If the dry matter digestibility of a diet is 87.5%, then the total amount of solids excreted by a 35 day old bird will be 0.34 kg and for a 49 day old bird it will be 0.63 kg.

At a manure moisture content of 90%, total manure production will be 3.4 kg and 6.3 kg for 35 and 49 day old birds, respectively.

The diets in meat chicken production vary with the age of the chickens. Typical diets contain approximately 3.5% nitrogen for starter chickens (first 10-14 days), declining to 3.0% nitrogen for finisher chickens (6 - 8 weeks). The phosphorus content of the diets ranges from about 0.8–0.9% and the potassium content of the diets ranges from about 0.6–0.7%.

The amount of nutrients, salt and ash retained by the bird will depend on its carcass composition (in terms of nitrogen (N), phosphorus (P), potassium (K), salt and ash)

and the liveweight gain. Table 1 shows typical carcass composition of a meat chicken in g/kg.

TABLE 1 CARCASS COMPOSITION OF A MEAT CHICKEN (g/kg)

Nitrogen	Phosphorus	Potassium	Salt (as NaCl)	Ash	Water
28.0	5.0	2.0	0.5	40.0	500.0

Using the figures from Table 1, each 1 kg of liveweight gain in a meat chicken will contain 28 g of N, 5 g of P, 2 g of K and 40 g of ash.

A nutrient mass balance for a meat chicken farm running 100,000 birds per batch and 5 batches per year is shown in Table 2. This farm was modelled to sell one third of the birds at 35 days and the remainder at 49 days. The liveweight turnoff is 1,210 t/annum.

TABLE 2 ANNUAL SOLIDS, NUTRIENTS, SALT AND ASH EXCRETED BY A 100,000 BIRD OPERATION, RUNNING 5 BATCHES/YR

Component	TS	N	P	K	Salt	Ash
Feed Usage (kg/yr)	2,041,089	71,024	19,890	13,870	1,787	129,583
Feed Composition (% as fed)		3.00-3.49	0.80-0.89	0.57-0.72	0.03-0.32	5.48-6.24
Output (kg/yr) (excreted + waste)	282,241	37,427	13,803	11,438	1,151	81,068

Assumptions:

Diet modelled was a sorghum/wheat based diet typical of Queensland.

Salt only includes NaCl in the feed, not salt in drinking water

Clean Bedding Types and Composition

To estimate the nutrient content of spent litter, the amount of clean bedding material added needs to be known. This can be calculated the following way:

$$\text{Bedding added (kg)} = \text{Floor Area (m}^2\text{)} \times \text{Bedding depth (m)} \times \text{Bedding density (kg/m}^3\text{)}$$

E.g. If sawdust, with a density of 300–350 kg/m³ is used as the bedding material and a farm runs 100,000 birds/batch in four sheds (105 m x 14 m), then:

For 100 mm of fresh bedding/batch = 192 t/batch or 1.9 kg/bird of fresh bedding.

For 50 mm of fresh bedding/batch = 96 t/batch or 1.0 kg/bird of fresh bedding.

Bedding material may also contain significant amount of nutrients. Table 3 shows the typical composition of different bedding material.

TABLE 3 NUTRIENT CONTENT OF VARIOUS CLEAN BEDDING MATERIALS

Content (% dry matter)	Total Solids	Nitrogen	Phosphorus	Potassium
Shredded Paper	90	0.09	0.01	0.00
Hardwood Sawdust	90	0.22	0.01	0.05
Softwood Sawdust/Shavings	90	0.14	0.01	0.03
Rice Hulls	90	0.90	0.01	0.00
Straw	90	0.63	0.06	2.13

Predicted Spent Litter Composition

The stocking density and the extent of the feed wastage largely determine the mass of nutrients in the spent litter. However, the concentration of the spent litter will vary depending on the amount and type of clean bedding used and the loss of nitrogen (mainly due to volatilisation of ammonia). The average amount of clean bedding added per batch is likely to be lower for operations that use partial reuse to multi-batch litter practices, compared to single batch litter.

Nitrogen losses in the shed may be highly variable and will depend greatly on the litter moisture content. Wetter litter will produce greater ammonia volatilisation. Measured values range from about 5% to 25% of the total nitrogen excreted, with typical values of 15%.

Table 4 shows predicted nutrient contents (dry matter basis) of spent litter under various management conditions. These values were calculated using mass balance principles based on the amount of nutrients excreted and the amount of nutrients in the clean bedding. The amount of total solids (dry matter) produced in t/yr for a 100,000 bird operation, producing 5 batches/yr is also shown. This table illustrates the potential for large variations in spent litter composition. The most accurate method for determining the composition of spent litter is to take a representative sample and have it analysed. Provided management practices (feed type, clean bedding type and amount) remain constant, the composition of the spent litter being produced should be relatively constant.

TABLE 4 PREDICTED NUTRIENT CONTENTS (DRY BASIS) OF SPENT LITTER UNDER VARIOUS MANAGEMENT OPTIONS

Bedding Material	Depth added/batch (mm)	Total solids (t/yr)	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Softwood Sawdust	100 (single batch)	1090	3.0	1.3	1.1
Softwood Sawdust	50 (Partial reuse)	680	4.8	2.0	1.7
Softwood Sawdust	25 (Multi batch)	470	6.8	2.9	2.4
Chopped Straw	100 (single batch)	770	4.5	1.8	3.1
Chopped Straw	50 (Partial reuse)	520	6.4	2.7	3.4
Chopped Straw	25 (Multi batch)	390	8.3	3.5	3.7

Assumptions:

Sorghum/wheat based diet typical of Queensland.

Feed wastage of 3%, 2% and 1% for starters, growers and finishers respectively.

Shed nitrogen volatilisation and total solids losses of 15% and 5% respectively.

Measured Spent Litter Composition

- Literature from the United States suggests that for every 1 kg liveweight of market bird, 0.5 kg of spent litter is produced. Thus, for an operation running 100,000 birds/batch, with 5 batches/yr and an average turnoff liveweight of 2.5kg, total annual manure production is 625 t.
- Literature suggests that meat chickens excrete approximately 60% N, 70% P and 80% K that is fed. This is similar to the rates predicted using mass balance principles.

Table 5 shows measured chemical and physical properties of spent litter from New South Wales meat chicken farms. No reference to clean bedding type and reuse practices (single or multi-batch) was presented with this data. Table 6 shows measured chemical and physical properties of spent litter from the three Victorian meat chicken farms in 1997 and 1998.

TABLE 5. MEASURED AVERAGE AND RANGES OF THE COMPOSITION OF SPENT LITTER – NEIL GRIFFITHS (NSW AGRICULTURE).

	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
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
Sulphur (S), % of dry matter	0.6	0.45 – 0.75
Carbon (C), % of dry matter	36	28 – 40
Weight per m ³ (kg)	550	500 – 650

TABLE 6. MEASURED COMPOSITION RANGE OF SPENT LITTER FROM THREE MEAT CHICKEN FARMS IN VICTORIA, 1997 AND 1998 – GREG PARKINSON, DNRE VICTORIA.

	Range
Dry matter, %	50 – 84
Nitrogen (N), %	2.3 – 3.6
Phosphorus (P), %	0.93 – 1.8
Potassium (K), %	0.9 – 1.7
Calcium (Ca), %	1.4 – 3.4
Magnesium (Mg), %	0.31 – 0.65
Sodium (Na), %	0.19 – 0.68
Sulphur (S), ppm	
Boron (B), ppm	
Selenium (Se), ppm	0.47 – 2.0
Zinc (Zn), ppm	180 – 250
Copper (Cu), ppm	47 – 120
Arsenic (As), ppm	2.6 – 13

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