Litter Reuse: An Evidence-based Guide to Reusing Litter

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Foreword

The Australian Chicken Meat industry has invested in a significant amount of research into understanding and applying litter reuse as a management technique in the Australian industry. Litter reuse (raising multiple batches of chickens on the same litter) is a safe and beneficial practice when managed correctly. The benefits of reusing litter include reduced cost and improved value for the chicken litter as a fertiliser after it is removed from chicken sheds. Concerns around pathogens, dust and odour have been raised, but recent Australian research has been completed to address these concerns. This guide summarises the recent research, providing a strong evidence base for litter reuse, and directing interested readers to more detailed research reports. The guide is intended for the poultry industry and those involved in regulating and licencing poultry production, such as local councils and state environment departments.

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This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our Chicken Meat R&D program, which aims to stimulate and promote R&D that will deliver a profitable, productive and sustainable Australian chicken meat industry.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

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Contents

Introduction .................................................................................................................. 7
Comparison of different types of litter management systems ........................................ 8
Advantages of multi-batch litter .................................................................................. 9
Perceived barriers to litter reuse .............................................................................. 9
Odour and dust emissions ......................................................................................... 10
Odour emissions ........................................................................................................ 10
Dust emissions .......................................................................................................... 10
Ammonia emissions ..................................................................................................... 11
Management of ammonia within a multi-batch litter system ...................................... 11
Food safety pathogens ............................................................................................... 12
Management of pathogens within a multi-batch litter system ..................................... 12
Poultry pathogens ...................................................................................................... 13
Guide for growers ...................................................................................................... 15
References .................................................................................................................. 15

Figure index

Figure 1. Odour Emission Rate. .................................................................................. 10
Figure 2. Ammonia concentration (ppm) in shed air for single use and reused litter. .......... 11
Figure 3. E. coli levels in litter before and after litter heaping and in different positions in the litter heap over time. ................................................................. 12
Figure 4. Percentage of chickens with FAV positive blood serum at day 35 post exposure to litter. ............................................................................................... 13
Introduction

Chicken litter reuse is the practice of housing multiple batches of meat chickens on the same bedding material (litter) before removing litter from the sheds for utilisation off site (eg. as fertilizer). This management approach is widespread in some countries (e.g. USA) but is not currently widely practised in Australia.

Litter reuse has the potential to reduce costs and improve the environmental sustainability of meat chicken farming. However, there are a number of barriers to increased uptake of this practice. This guide provides results from recent Australian research that highlights new findings that show litter can be reused without adverse effects on production or the environment, provided it is appropriately managed.

The guide provides information on:

- Practices for litter reuse.
- Odour and dust emissions.
- Ammonia emissions.
- Pathogens of food safety significance.
- Control of poultry diseases.
- Management techniques to overcome perceived barriers.

A typical pile of spent chicken litter from the grow-out phase of chicken meat production
Comparison of Different Types of Litter Management Systems

Chicken litter is a by-product of meat chicken production and is a mixture of bedding (usually sawdust or shavings, rice hulls or straw) and manure.

The two common litter management approaches are single use litter and multiple batch litter (litter reuse). Litter reuse can be categorised as either full reuse or partial reuse.

As the name suggests, single use involves completely removing the litter from the shed at the end of each batch. After clean-out, the shed is disinfected prior to placing new bedding for the next batch. This is the most common practice in Australia because of a perception that clean bedding improves bird health and for amenity issues such as odour emissions.

Litter reuse generally involves removing any caked litter at the end of each batch, washing and disinfecting the shed and sometimes covering the brooding end with 25 to 50 mm of new bedding material prior to placement of the next batch of chickens. In Australia, in cases where litter reuse is practised, the litter is typically reused for 3-5 batches. In the USA litter is sometimes reused for several years (more than 15 batches of chickens).

Partial reuse of litter typically involves removing old litter from the brooding section of the shed and spreading it on the grower section and then placing new bedding material in the brooding section.

Between batches, reused litter may be heaped in the shed prior to being re-spread. This process relies on the natural composting process which begins rapidly, without water or other additives, after the litter is heaped. The composting process creates heat which acts to kill pathogens and viruses that may be present in the litter. However, the effectiveness of this can be constrained by the time available between batches.
Advantages of Multi-batch Litter

There are numerous benefits to utilising a multi-batch litter system compared to single use litter, including:

• Less fresh bedding required.
• Less transport for spent litter.
• Higher value for land application (as fertiliser).
• Generally drier litter (following heaping or piling between batches) than fresh bedding.
• Shorter clean-out periods, thereby reducing periods of fugitive odour emission.
• Less labour may be required for clean-outs.

These benefits result in lower costs for growing out chickens, and can make production more sustainable in the long run because less fresh bedding material is required and transport requirements are reduced.

Perceived barriers to litter reuse

There are a number of perceived barriers associated with litter reuse. These are as follows:

• Increased odour emissions.
• Increased dust emissions.
• Increased in-shed ammonia concentration, particularly during brooding.
• Increased pathogens of food safety significance.
• Increased risk of poultry disease transfer to subsequent batches.

Several recently completed research projects have investigated these issues to determine whether the above perceived risks are actual or real, and to investigate management approaches to overcome these issues. These are discussed in detail in the sections that follow.
Odour and Dust Emissions

Concerns have been raised over whether multi-batch litter reuse results in higher levels of odour and dust than single batch litter use. However, Australian research (described below) suggests that the differences are minor.

Odour emissions

Experimental work compared odour emission rates from single use and partially reused litter systems\(^1\). The partial reuse practice was as described above, where all litter is moved to the grower section of the shed and fresh shavings placed in the brood area of the shed. These researchers found that, for single use litter, measurements for odour emissions ranged from 337 to 2,939 ou/s per 1,000 birds placed in the shed at the start of the batch, while for partially reused litter, odour emissions ranged from 669 to 2,806 ou/s per 1,000 birds (Figure 1). The mean Odour Emission Rate (OER) was found to be 1,505 ou/s per 1,000 birds placed in the shed at the start of the batch for single use, and 1,393 ou/s per 1,000 birds for partially reused litter respectively.

Measurements for OER per kg of liveweight ranged between 0.53 and 1.84 ou/s per kg of liveweight for single use systems, whereas they ranged from 0.65 to 2.12 ou/s per kg of liveweight for partially reused systems. The mean OER measured during the single use and partially reused batches was 1.16 and 1.10 ou/s per kg of liveweight respectively.

There was no significant difference in OER rates per 1,000 birds placed between single use and partially reused litter. Similarly, when OER per kg of liveweight were measured, there was no significant difference between these litter systems.

Dust emissions

Research investigating dust emissions from single and multi-batch (partial reuse) litter systems found that emissions were higher from the partial reuse system\(^2\). However, the authors note that moisture levels were lower in the partial reuse experiment, which may have confounded the results. Dust emissions from partially reused litter were within the range measured previously for chicken meat production in Australia. The average diameter of dust particles from reused litter was found to be slightly smaller compared to single batch litter.

Slightly higher dust levels from reused litter were also found in other experimental work\(^3\), where good quality reused litter that has been treated by heaping between batches has been found to be considerably drier than fresh sawdust bedding.
Ammonia Emissions

Ammonia concentrations within meat chicken houses can cause health concerns where levels exceed 25 ppm. Recent Australian research has shown that litter reuse results in higher ammonia concentrations (Figure 2), although in this research these concentrations were well below the threshold of 25 ppm where bird health may be compromised. Further research conducted by this research team, expected to be published in early 2015, has confirmed the finding of higher ammonia levels with reused litter.

Ammonia concentrations for multi-batch litter are likely to be higher than for single batch, and care should be taken to manage this risk to bird health, particularly during brooding in winter. However, this is unlikely to pose a major risk with partial (as opposed to full) reuse systems.

Management of ammonia within a multi-batch litter system

In-shed ammonia concentrations in single and multi-batch use systems can be managed in a number of ways if they become a concern. These include increasing ventilation and the use of litter additives such as urease inhibitors, clinoptilolite forms of zeolite, acidifying agents and microbes that have the ability to tie up nitrogen. All of these additives appear to work in reducing ammonia concentrations from litter. Currently, use of these additives in Australia in either single or multi-batch systems is minimal.

Figure 2. Ammonia concentration (ppm) in shed air for single use and reused litter.

Means of measurements made at 30cm height at 15 min intervals for 16-22 hours.

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Food Safety Pathogens

One of the perceived barriers with reusing litter is the possibility of an increase in levels of bacterial pathogens of food safety significance in litter and thus the possibility of transfer of key food safety pathogens such as *Salmonella* and *Campylobacter* across sequential batches of chickens. Research has focused on managing this risk by using composting processes to reduce pathogens in the litter between batches of chickens.

Management of pathogens within a multi-batch litter system

Composting processes can be effectively harnessed to reduce pathogen levels in litter. This can be achieved in a limited period of time (typically 3-7 days) by heaping or piling litter between batches. The aim is to allow the litter to reach a high enough temperature to kill the pathogens present in the litter. This approach has been found to be effective in substantially reducing pathogens by several studies.

Heaping litter intended for reuse for the subsequent batch lead to the control of pathogen levels within the reused litter. *Salmonella*, *E. coli* (Figure 3) and *Campylobacter* levels were shown to decrease through the process. Pathogen levels in reused litter that was heaped for 6 days were found to be below the detection limit, when tested again after spreading prior to placement of chicks for the subsequent batch.

Research has demonstrated that ‘pasteurising’ (abbreviated windrow composting) of used litter led to a reduction in pathogen levels. Stockpiles reached maximum temperature in an average 2.3 days following piling, indicating that a minimum of 3 days is required to complete the ‘pasteurisation’ cycle. Increasing the moisture content of litter (to 35%) provided no benefit for heating compared to heaps that did not receive added water. Overall, adding water was found to make managing the litter more difficult and was not recommended.

Heaping reused litter between batches has been shown to effectively control of bacterial pathogen levels by Australian researchers.

![Figure 3. E. coli levels in litter before and after litter heaping and in different positions in the litter heap over time.](image-url)

*The research shows that after 6 days, pathogen levels were below the detection limit.*

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1. Laravale - November 2006 following cycle 1 (New Litter)
Levels of *E. coli* in spread litter (Feeder/Drinker) & over time in indicated Pile positions

2. 0 D
3. 3 D
4. 6 D

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The research shows that after 6 days, pathogen levels were below the detection limit.
Poultry Pathogens

Another perceived barrier to reusing litter is the possibility of poultry disease transfer between batches of chickens. Pathogens of concern include bacterial, parasite and viral agents, although most work in this area to date has been on viruses.

Recent Australian research investigated the effect of different physical treatments on parasite and virus survival in reused litter. Treatments included heaping litter, heaping then turning litter, and windrowing litter.

A number of important diseases for meat chickens were investigated, including coccidiosis, Marek’s disease virus (MDV), fowl adenovirus/inclusion body hepatitis (FAV), chicken infectious anaemia virus (CAV) and infectious bursal disease virus (IBDV). Coccidial oocyst counts and virus levels, determined by the rate of seroconversion of SPF chicks placed on the litter, were measured every three days through to day 9 of treatment.

In these trials, heaping was found to be effective for reducing disease incidence in the case of most disease agents. Results showed that coccidial oocysts were readily inactivated after 3 days of treatment, FAV was largely inactivated after 6-7 days of treatment, and CAV and IBDV were largely inactivated by days 6–10 of treatment. Unlike the other viruses, MDV inactivation was not affected by treatment, but declined over time (although still showed infectivity even after 9-10 days).

The results also showed that infectivity of most disease agents was reduced in litter treatments that generated higher temperatures, that heaping may be more effective than windrowing and that turning of heaps did not improve the effectiveness of the treatment in inactivating disease agents.

Heaping reused litter between batches has also been shown by Australian researchers to be effective in reducing levels of exposure to many major endemic parasitic and viral diseases.

Figure 4. Percentage of chickens with CAV positive blood serum at day 35 post exposure to litter.

Interaction plot of effects of treatment and day of litter collection post heaping.

Figure 4. Percentage of chickens with CAV positive blood serum at day 35 post exposure to litter.

Interaction plot of effects of treatment and day of litter collection post heaping.
Guide for growers

• Reuse of litter does not increase the burden of food safety pathogens, such as Salmonella and Campylobacter, if treated correctly between batches.
• Reuse results in similar odour emission rates as single use litter.
• Reused litter is slightly dustier than single use litter.
• For both odour and dust, litter management (especially litter moisture content) and environmental factors are likely to have a greater influence on emissions than litter reuse status.
• Reuse can potentially increase ammonia levels in sheds, and care needs to be taken to manage this risk to bird health, particularly during brooding in winter. The risks are lower (and more manageable) with partial reuse than full reuse.
• Treatment of litter by heaping / piling between batches effectively reduces the risk of disease carry-over between batches for many endemic poultry disease agents, where litter is reused. The effectiveness and number of days of treatment required varies for different disease agents (eg 3 days sufficient for coccidiosis; 9-10 days for some viruses). Further research on additional viruses is currently underway.
• It is expected that a Litter Reuse SOP (for poultry pathogens) will be produced in 2015 under a Poultry CRC project.

Summary

Litter reuse is a practice that can enable efficiency improvements in the chicken meat industry without adverse impacts on production or the environment, when properly managed. Recent Australian research shows that odour emissions are similar from multi-batch litter and single use litter, while multi-batch litter has slightly higher dust emissions.

Some factors may require more management when reusing litter. For example, ammonia emissions may be higher in multi-batch than single batch litter. With appropriate monitoring and management, suitable levels can be maintained for bird production.

Pathogens associated with food safety and bird health may be treated by heaping/piling litter between batches, and standard operating procedures are under development to assist in minimising pathogen load.

These results suggest that litter reuse can be a useful and beneficial practice to reduce costs and improve litter value without detrimental impacts on the environment or bird health, provided good management practices are followed.

References

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The authors would like to thank the many researchers who have completed the detailed research that underpins this guide for the RIRDC over the last 10 years. This research is summarised and referenced in full in the accompanying report for this project, available from the RIRDC:

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