International Journal of Engineering Research and General Science Volume 6, Issue 1, January-February, 2018
ISSN 2091-2730

A Study on the Concept of Reutilization of Litter in Broiler Poultry Farms

Karthiga Saravanan

Scholar in Vels Institute of Science, Technology and Advanced Studies, Chennai,

78.karthi@gmail.com,

Abstract— Broilers are known to offer the cheapest source of protein among the non-vegetarian diet and it is widely accepted by everyone. The short incubation time, low risk and quick yield has made many animal agriculture farmers to adopt rearing broilers. The rapid growth in this sector makes it inevitable to address the environmental issues that arise due to it. The inefficient management of wastes from the poultry farms poses serious threat to our environment. Poultry litter is the major solid waste generated from a farm. There has been an increasing demand in obtaining the raw material for bedding as well. This paper is a collection of methodologies that could be adapted to re-use poultry litter.

Keywords— Poultry litter, coconut fibre, reutilization, chemical treatment, composting, windrowing, environmental pollution

INTRODUCTION

Chicken is the cheapest source of animal protein that is being widely accepted and consumed in our country. Poultry industry is the fastest growing sector of Indian agriculture and proves to be a lucrative enterprise for farmers. According to the Poultry and Poultry Products Annual 2016 report, from Global Agricultural Information Network, India's chicken meat consumption for the year 2017 is projected as 4.49 million metric tonnes which is 7% higher than the year of 2016.

As the industry continues to expand and increase in concentration, the need to address environmental issues is more critical. Though the need for chicken is inevitable, livestock production in India poses a grave environmental concern in terms of carbon emissions, land and water usage and pollution. It is high time that we ensure that the infrastructure, rearing processes and waste disposal techniques in poultry farms are economical and environmentally sustainable.

POULTRY INDUSTRY IN INDIA

The global market for poultry meat has been rapidly growing as it is more versatile, cheaper and has more health benefits than red meat. [4] Historically, attributes such as high protein and energy, rapid turnover rate and short incubation rate proved to be advantageous than other livestock animals and paved way for the growth of poultry sector. [3]

Poultry Industry in India, is the largest livestock group contributing to about 30% of animal protein [8]. It is one among the fastest growing sectors in India with about 8% growth rate per annum. [11] Indian poultry industry is concentrated to certain specific areas of the country such as Andhra Pradesh, Telangana, Tamilnadu, Maharashtra, Punjab and West Bengal.

The 5000 year old industry offers one of the cheapest sources of protein, providing nutritional security to the poor and also employment opportunities to large mass of people. [7] Farmers have started to depend mostly on poultry farm for their livelihoods, thereby, playing a major role in alleviation of poverty in India. [10]

A study conducted on the growth of poultry industry in the year of 2020 estimates that the consumption of total poultry meat to increase from 687 million kilograms to 1674 million kilograms. [13]

ENVIRONMENTAL IMPACT OF POULTRY SECTOR

The environmental impact of this sector has grabbed an ever growing attention. Animal production aims to produce animal proteins in a sustainable manner. Sustainability is a complex phenomenon, which includes integration of economic, social, and environmental dimensions of the certain production, within a given socio-economic context. The increased consciousness of environmental pollution of livestock rearing poses a challenge to animal and agricultural scientists to expand and improve the waste disposal systems or to recycle the waste nutrients wherever possible.

Poultry provides affordable dietary item for consumers and profit for producers. Its sustainability in terms of environment is questionable Research shows that broiler meat production stage poses a great burden on the environment in comparison with the entire life cycle of a chicken [15].

Poultry sector has rapidly grown and made several changes to meet the demands. The intensification and concentration of the

operations has laid huge impact on our environment. Poultry production seems to be an environmentally friendly process. However, it still contributes to eutrophication, acidification and global warming. Manure management in farms contributes to about 40 – 60% of eutrophication and acidification potential [5]. Poultry production is associated with a variety of pollutants, such as oxygen-demanding substances, ammonia, solids, nutrients (specifically nitrogen and phosphorus), pathogens, trace elements, antibiotic residues, pesticides, odour and other airborne emissions. Accumulation of nutrients and trace elements from animal manure can become toxic to plants. Other indirect impacts are ecosystem destruction and biodiversity erosion associated with the expansion of feed crop production into natural habitats and the overexploitation of non-renewable resources for feed production [9].

The massive amount of nitrogen, phosphorous, and potassium generated by poultry litter has a serious detrimental impact on the environment. Inefficient management of wastes can cause these chemicals to be washed away by surface runoff. High concentration of these chemicals in lakes and ponds can cause excessive algal growth causing taste, odor, and aesthetic problems and decreasing the value for water supply and recreation.

Gaseous pollutants of poultry farms originate from the breakdown of fecal matter present in the litter. Their concentrations depend on the rate of ventilation, ventilation efficiency, the stocking density and movements of the animals. The most common air pollutants are ammonia, nitrous oxide, methane, and carbondioxide. Modification of housing and manure handling is the primary action for reducing such emissions.

The antibiotics are extensively used in animal farming. The waste residues from farms will contain antibiotic resistant genes that can contaminate our environment as well.

The most prominent need of area of research are: Identification and calculation of various generic environmental indicators that are used in meat chain and a research on the existing environmental practices regarding consumption of water and energy, waste water quality and amount of waste generated.

Overall the major environmental issues of poultry meat industry can be narrowed down into:

- air quality concerns due to emission of greenhouse gases, particulate and volatile compounds including volatile organic compounds (VOC) and ammonia;
- aesthetic concerns regarding emissions of odour, pathogens, endotoxins, noise, light and pests;
- soil and water quality concerns as nutrient moves from production facilities and storage areas and heavy metal, pathogen and anti-microbial contamination from application of poultry litter to soil.

BEDDING MATERIAL IN POULTRY FARMS

Organic materials such as corn cobs, corn stalks, straw, peat moss, peanut hulls, wood shavings, oat hulls, pine shavings are known to be used as bedding for rearing broilers.

The quality of bedding material is of great concern in broiler production as it affects performance, health, carcass quality, and the welfare of broilers. Bedding materials can influence the prevalence and severity of footpad dermatitis in broilers. This effect is associated with the ability of bedding to protect footpads from continuous contact with moisture, thereby minimizing footpad softening and susceptibility to irritation and inflammation.

A good bedding material can be identified with the following factors:

- It should be highly absorbent acting like a blotting paper providing dry comfortable space for broilers and also absorbing all the moisture;
- The drying time should be reasonable;
- Easily available;
- Cost-effective
- Non-toxic to poultry as the birds consume up to 4% of litter in their diet.
- Litter material should be free from dust, with no more than 15% of it consisting of particles smaller than 2 mm.
- Insulates chicks from the cooling effects of the ground and provides a protective cushion between the birds and the floor.
- Litter should not contain oversized particles as this may let the litter to form cakes within the first two weeks.

An alternative, economical and efficient source of bedding material with favorable, environmentally-friendly characteristics that allows recycling or reducing waste is of prior concern for broiler producers.

POULTRY LITTER

Litter is defined as the combination of bedding material, excreta, feathers, wasted feed and wasted water formed as a result of intensive poultry production. Litter quality determines the quality of the in-house environment.

The two factors that influence litter conditions most are manure and moisture. Excess moisture in the litter increases the incidence of breast blisters, skin burns, scabby areas, bruising, condemnations and downgrades in the birds and also acts as an active medium for proliferation of pathogenic bacteria and molds. Dry and dusty litter can lead to problems such as dehydration of new chicks, respiratory disease and increased condemnations. [2]

Considering that each bird produces an average of 1.8 kg of waste during its lifetime, approximately 10 Mg yr^{-1} of poultry litter is generated.

COMPOSITION OF POULTRY LITTER

Understanding the microbial community and composition of animal wastes such as poultry litter is essential to manage animal disease and limit the impact of animal waste on the environment and human and animal health. (Jingrang Lu et al., 2003)

Litter waste predominantly consists of water, carbon (C), nitrogen (N) and phosphorus (P), and lower levels of chlorine (Cl), calcium (Ca), magnesium (Mg), sodium (Na), manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), and arsenic (As). These levels vary among broiler houses and regions, based on the bedding material used, number of flocks reared, drinking systems, hygiene status, cleaning method, and storage principles [14]

The litter also contains pesticide residues, pharmaceuticals such as coccidiostats, endocrine disruptors and microorganisms. As with other organic wastes, the moisture content, pH, soluble salt level, and elemental composition of poultry manure and litter have been shown to vary widely as a function of Poultry litter, types of poultry, diet and dietary supplements, litter type, and handling and storage operations. [11]

The composition of broiler litter within a poultry farm was found to vary spatially and seemed to be associated with its varying degree of decomposition.

Ammonia

The free ammonia will be in one of two forms: as the charged form of uncharged form of ammonium ion (NH4), or uncharged form of NH3 (ammonia) depending on the pH of the litter. The ammonia concentration increases with increase in litter pH. There is a substantial increase in the concentration when the pH is above 8. Ammonia levels above 25ppm can cause respiratory problem to birds and allow the attack of pathogens.

Moisture

A microaerophillic to anoxic microenvironment can be observed underneath the surface of wet litter especially near the drinker. On an average the Moisture content of dry litter samples should range from 10–25% and wet litter from 43–67%. (Michael D. Dumas et al, 2011) The water content of the poultry waste will depend on the hygroscopic capacity of the organic materials used in the beds, season of the year, and management of the birds in the barn, mainly related to the kind and position of drinkers and the ventilation system.

Carbon Content

The amount of C in poultry litters varies according to the material used for bedding, the number of flocks produced in the same bed, and the environmental conditions (temperature, moisture, ventilation, etc.), which affect the decomposition rate of the wastes in the barns. As the poultry grow, the amount of excreta over the bed increase and this promotes a decrease in the C/N ratio.

Phosphorous

Broiler diets contain Phosphorus to ensure rapid animal growth. Consequently, litter contains phosphorous in a variable amount generally ranging from 9.8 to 27.1g/kg, with the majority in a soluble form. [6]

Microbial Content

Poultry manure contains a large and diverse population of viruses, bacteria, fungi and protozoa. Their concentration can exceed 10^{10} cells/g of poultry litter. The litter may contain several zoonotic pathogens, such as *Escherichia coli, Salmonella spp., Campylobacter jejuni, Listeria monocytogenes, and Clostridium perfringens*. [11]

GENERAL USES OF POULTRY LITTER

Several opportunities for usage of poultry litter as an efficient way to manage wastes have been implemented. Poultry litter can be used as cattle feed, as a fuel source and as a fertilizer for plants.

Poultry litter is often used as an organic nutrient source in forage, cereal and fibre crop production. Excessive application can cause undesirable effects on forage crops and animals consuming the forage [11]. However, for environmentally and economically sound applications of poultry litter, it is crucial to know the decomposition rate of and nutrient release from the litter. [3]

Litter when effectively managed can be used as a fuel source for a gasification furnace. However, prolonged usage of the litter will lead to formation of slag thereby, reducing the efficiency of furnace.

The litter management approaches that could be adopted are single use litter and multiple use litter. The multiple use of litter can further be done as a complete reuse or partial reuse in the broiler farms. [15]

RE-UTILIZATION OF BROILER LITTER

Broiler litter reutilization refers to the usage of the same bedding material to cover the house floor for several batch of broiler flocks. [14]

Reuse of litter also has a nutritional advantage. In the bacterial action that takes place, there is a considerable synthesis of B-complex vitamins, including vitamin B12. Except when the ration has an ample supply of these vitamins, the growth of chicks or the egg production of hens may be appreciably increased by keeping them on reused litter. Such responses may only be obtained with a definite determination that the litter is clean and has no disease organisms.

There are certain perceived inconveniences on re-using litter. They are:

- Increased risk of odor emissions.
- Increased dust emissions.
- Increased concentration of ammonia in shed, particularly during brooding.
- Increased pathogens of food safety significance.
- Increased risk of poultry disease transfer to subsequent batches. [15]

Litter can be composted through windrow composting in-house to reduce the bacterial and viral loads. In this methodology, temperatures of 130 F or greater are created to reduce bacterial numbers and kill or reduce most viral pathogens. A period of three to five day in-house composting program between flocks would be a useful way to reduce the microbial load and improve bird performance.

Downtime between each batch of flocks needs to be 10-14 days to allow growers to complete the composting and still have time to prepare for chick delivery.

Composting methodology too could be implemented via., different techniques. One such technique is piling the litter and composting in house. This technique was more effective in reducing the nitrogen content, humidity and pH in the litter. [14] The heat created during the composting process can kill the pathogens that may be present in the litter. [15]

Windrowing: In this method the litter is scraped into long rows within the poultry house and allowed to sit for five days maintaining a temperature of +54°C.This is said to reduce the pathogen load on the litter [2]. Heaping litter for the subsequent batch lead to the control of pathogen levels within the reused litter. The levels of Salmonella, E. coli 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, while being used for the next batch of chicks. The result shows that infectivity of most pathogens was reduced in litter treatments that generated higher temperatures. Hence, heaping may be more effective than windrowing and that turning of heaps did not improve the effectiveness of the treatment in inactivating disease agents. [15]

CHEMICAL TREATMENT OF LITTER

Sodium bisulphate: Sodium bisulphate is a non-hazardous and easily available chemical that could be used in litter treatment. The usage of this chemical is found to lower the pH of litter and ammonia levels. It eliminates ammonia by converting ammonium in the litter to ammonium sulfate. The beetle populations and bacterial populations of Salmonella and Camphylobacter were also lowered.

Addition of acidifiers to litter is found to convert ammonia to ammonium which is a relatively stable form and does not get converted to gaseous state easily. [1]

The extract of *Yucca schidigera*, a natural feed additive can be added to the diet of poultry to reduce the level of ammonia formation within the poultry house.

The ammonia concentration (should not exceed 25ppm) could be controlled by increasing the ventilation and the using litter additives such as urease inhibitors, clinoptilolite forms of zeolite, acidifying agents and microbes that have the ability to tie up nitrogen. [15]

Aluminium sulphate: Aluminium sulphate is another dry acid salt which could lower the litter pH and bind to phosphorous making it less reactive in the litter. Aluminium sulphate should be applied 3 - 4 days before placement in the house when the litter is wet, and 6 - 7 days before placement when the litter is dry. [1]

Feed Grade Salts: Feed grade salt can be applied to destroy organisms that may be present even after clean out and disinfection. The salt is highly corrosive hence; it should be lightly wet and made to dissolve before application. [1]

CONCLUSION

On reusing litter the solid waste generated from the poultry farms could be minimized. The pressure on obtaining raw materials for bedding will be reduced. Owing to the inefficiency in the waste disposal methods, the concept of reducing the waste from its point of generation by reusing it is alluring. This study would open a new gateway for poultry litter management in India thereby lowering the stress of waste disposal on our environment.

REFERENCES:

[1] Dr. Bradley J. Turner, "Reused Litter Treatments for Improved Bird Health" Aviagen Brief, August 2008

[2] Casey W. Ritz, Brian D. Fairchild, and Michael P. Lacy, "Litter Quality and Broiler Performance" August 2005

[3] Ekenma Kalu, "Poultry Litter/Manure Management Practices in Intensively Managed Poultry Farms in Portharcourt" IOSR Journal of Agriculture and Veterinary Science, Volume 8, Issue 3 Ver. II, PP 53-58, March, 2015

[4] Hui-Shung Chang, "Overview of the World Broiler Industry:Implications for the Philippines" Asian Journal of Agriculture and Development, Vol. 4, No. 2, 2007

[5] Ilkka Leinonen and Ilias Kyriazakis, "How can we improve the environmental sustainability of poultry production?" Proceedings of the Nutrition Society, 75, 265–273, March, 2016

[6] Kelleher, B. P., Leahy, J. J., Henihan, A. M., O'Dwyer, T. F., Sutton, D. & Leahy, M. J. "Advances in poultry litter disposal technology – a review" Bioresource Technology 83, 27–36, 2002

[7] Mohd Mujahed Ali, "Emerging Prospective of Indian Livestock: A Study on Poultry Industry" Asian Journal of Managerial Science, ISSN: 2249-6300 Vol. 4 No. 1, pp.33-39, 2015

[8] Permin, G. Pedersen, and J.C.Riise, "Poultry as a Tool for Poverty Alleviation: Opportunities and Problems Related to Poultry Production at Village Level" 2000

[9] P. Gerber, C. Opio and H. Steinfeld; Poultry production and the environment – a review; Poultry in the 21**st** Century, 2012

[10] Pradeepta Kumar Rath, Kruti Debnath Mandal and Pratikshya Panda, "Backyard Poultry Farming In India: A Call for Skill Upliftment" Research Journal of Recent Sciences, Vol. 4(IVC-2015), 1-5, 2015

[11] N.S. Bolan, A.A. Szogi, T. Chuasavathi, B. Seshadr, M.J. Rothrock JR., and P. Panneerselvam, "Uses and management of poultry litter" World's Poultry Science Journal, Vol. 66, December 2010

[12] R.N. Chatterjee and U. Rajkumar, "An Overview of Poultry Production in India" Indian Journal of Animal Health, December, 2015, 54(2) : 89-108

[13] Samarendu Mohanty and K.Rajendran, "2020 Vision for Indian Poultry Industry" International Journal of Poultry Science, 2 (2): 139 – 143, 2003

[14] Sonoda LT, Moura, DJ, Bueno, LGF, Cordeiro, DC, Mendes, AS, "Broiler Litter Reutilization Applying Different Composting Concepts" Brazilian Journal of Poultry Science, ISSN 1516-635X Jul - Sept 2012/ v.14 / n.3 / 159-232

[15] S.G. Wiedemann, "Litter Reuse: An Evidence-based Guide to Reusing Litter" Rural Industries Research and Development Corporation, 2015

[16] Talayeh Kalhor, Ali Rajabipour, Asadollah Akram, Mohammad Sharifi, "Environmental impact assessment of chicken meat production using life cycle assessment" information processing in agriculture, 3; 262–271, 22 October, 2016