

An assessment of Poultry Farms for Poultry Litter Production, Disposal and Its Use as a Fertilizer

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Abstract

The poultry sector is a growing sector that generates a huge quantity of poultry litter (waste) worldwide. This study examined the current status of the poultry activities, litter disposal procedures as well as its effects on wheat production in the Haripur District (Pakistan). In view of this, a questionnaire survey was conducted among 73 poultry concerns and 34 farmers. The respondents to the questionnaire revealed that 82% of the poultry farms raised broilers, while the remaining 18 % were dealing with layers. The poultry farmers used rice hull (94%) and sawdust (6%) as bedding material with an average layer of 6 cm. A total of 802500 birds were raised, generating 618766 kg of poultry waste annually. According to the survey, it was observed that poultry litter was used as fertilizer on agricultural land. Among this waste, 84 % of farm owners sold poultry litter directly (raw litter) to the farmers, while the other 16 % disposed of it (post-storage) in premises of their farms. This investigation concluded that applying post-storage litter as fertilizer led to a 21 % increase in wheat production than raw litter application while open storage produced an unpleasant smell, attraction of flies, released toxic gases and reduction of essential nutrients. It is therefore recommended to alter the method of litter storage and its application to agricultural land, to make poultry waste a safe and effective fertilizer.

Key words: Broiler; Fertilizer; Layer; Poultry industry; Raw Litter.

1. Introduction

A robust growth of the poultry industry has been observed around the world. Poultry farming makes a substantial contribution to economic growth and food production. In Pakistan, the poultry farming is a major agro-based crop growing sector with annual growth rates of 8-10 %¹. Globally, Pakistan is placed 11th among poultry producers². During 2016-2017, poultry industries contribute approximately 1.4 % to the Gross Domestic Product (GDP), 31 % of total meat production, and also engaged 1.5 million people as employment³.

Intensive poultry production generates waste in the form of poultry litter. Poultry litter produced in bulk can pose negative impacts on our environment. Similarly, to meet the needs of the growing population, the dependency on fertilizer is likely increase. The usage of the litter as a fertilizer is one of the options to reduce this dependency⁴.

The literature revealed that poultry litter is the one of the vital source of nutrients which enhances the agriculture production^{4,5}. Poultry litter is also considered as back bone to agriculture and plays a dynamic role in the agriculture sector. Study conducted in Sindh province, Pakistan reported that poultry sector contributes 14.4 % of the agriculture sector^{1,6}. In Pakistan, Wheat is considered the most valuable staple cereal that provides 3 % of the country's GDP⁷. Farmer also uses fertilizer to enhance the production of crop. Currently, poultry litter as organic fertilizer is receiving more attention due to the rising cost of inorganic fertilizers⁸. According to the Crop Statistics Khyber Pakhtunkhwa 2018-19, Wheat is grown on an area of 32507 hectares with the production of 63700 tonnes and 5345 tonnes of

fertilizers was being used in Haripur (Pakistan) ⁹. According to the report on Fertilizer, 20 % of the farmers used organic fertilizer to wheat crop ¹⁰. However, we are still on the way to get maximum production from the wheat crop due to different obstacles and challenges like inadequate and low quality nutrients supply, under dose application, for the production of crop ¹¹.

Poultry litter has detrimental potential harmful impacts on its direct application to agricultural land. These include negative effects on production or growth of crop and metal polluted soil which may become a part of the food chain. But proper management of litter may be beneficial to the farmers ¹². Mostly farmers stored poultry litter in the open air before its application to the cropland. This is one of the good options to utilize poultry litter but it is time-consuming and causing environmental pollution due to loss of nitrogen and other nutrients and leaching of nitrate ^{5, 13}. However, there is need to alter the method of litter disposal and utilization. The application of amended litter enhances the physico-chemical properties of the soil ¹⁴.

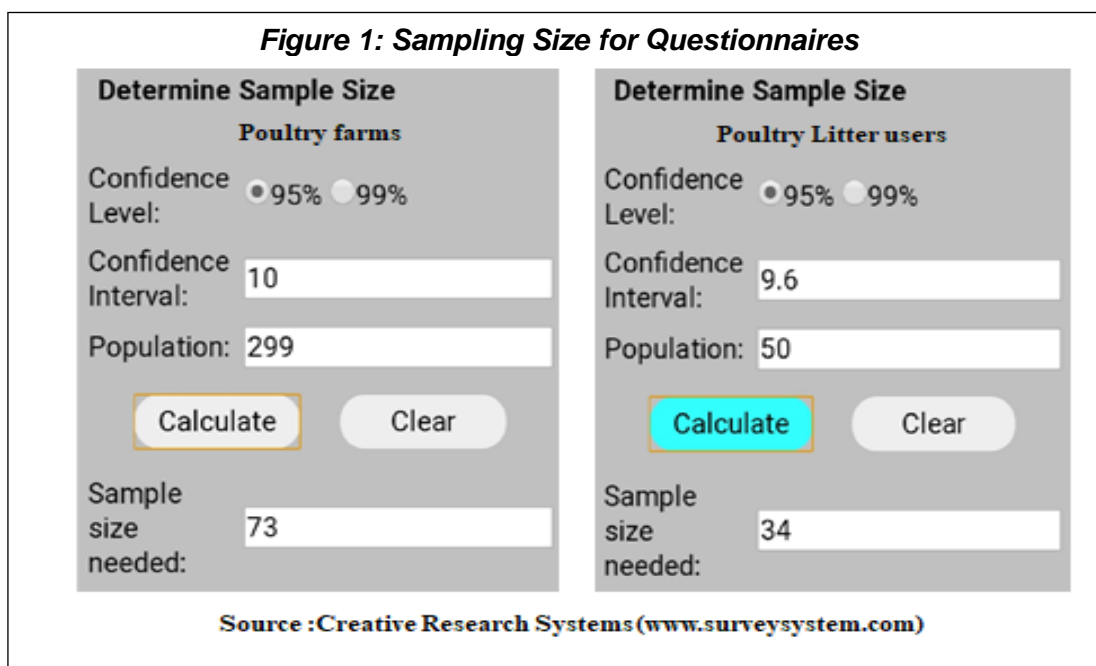
The main objective of this study was to quantify the huge waste generated by poultry farms, investigate the disposal procedure of and the effect of poultry litter on a wheat crop as fertilizer in Haripur district (Pakistan). In addition, to search out safe and environment friendly solution for effective application of poultry litter as fertilizer.

2. Research Methodology

The methodology of the study is based on field visits, self-observation, interviews, and questionnaire survey. The nature of the study was both qualitative and quantitative.

2.1. Field Visit. For assessment of poultry farming and collection of preliminary data, 3 field visits were paid i.e. before the start of poultry activity, mid of the cycle and after completion of poultry cycle. To know about the current status of poultry farms, 73 poultry farms (including both broilers and layers) were visited and kept under observation for a complete cycle.

2.2. Questionnaire Survey. The questionnaire consisted of structured and unstructured questions were administered to collect relative information. The questionnaire included various parameters as information about farm area, bedding, number of chicks, litter disposal and its utilization etc.



2.3. Sampling Procedure for Questionnaire. To determine sample size i.e. the number of respondents required in a survey, an online sample calculator was used (Figure 1)¹⁵.

In the selected study area (Haripur, Pakistan) 299 poultry farms were reported by³. A sample size of 73 random respondents was selected according to the calculator. Among these 73, 50 poultry farms concerned were connected with the production of wheat. A confidence level is the probability about the value within a specific range. Thus, the sample size was 34 respondents that were associated with the application of poultry litter. The confidence level was 95 % and 10 % margin error for both poultry farms and farmers (Figure 1).

2.4. Determination of Litter Quantity. The poultry litter production was calculated by using equation 1 as described by¹⁶. According to their report; the calculation of poultry litter production is based on the live weight of the birds. Furthermore, the value of 17.7 kg of manure for 1000 kg body weights and 0.9 kg/bird live weight was reported for broilers and layers¹⁶. The quantity of poultry litter was measured in kg/day (dry weight).

$$\text{Poultry litter production} = \frac{\text{Totalbirds} \times \text{live weight of bird} \times 17.7}{1000} \dots\dots\dots \text{(Equation 1)}$$

2.5. Data analysis. The results obtained from questionnaire were subjected to simple descriptive analysis on Microsoft Excel and presented in the simple frequency.

3. Results and Discussion

In view of the field observations, it was found that poultry houses were equipped with water containers, feeders, ventilation systems, cooling fans, and heaters. The buildings of farm houses were opened from the sides for cross ventilation. As a general practice, day-old chicks were brought to the poultry farm. The chicks were very small, soft, and delicate and needed high temperature and more light to search for food. The temperature was measured regularly and adjusted according to the condition of the chicks by the operator. Over time, the temperature and light intensity decreased. The temperature of poultry farms varies with the age of the chicks during the poultry cycle. Poultry farming is a very sensitive business. The first few days were very critical and required extra attention.

3.1. Type and Production of chicks in the selected Poultry Farms. The findings of the survey were presented in Table 1. A total of 73 visited poultry farms, 63 poultry farms were associated with broilers activity, while 10 poultry farms were dealing with layers. A single flock produced a minimum of 500 and a maximum of 4500 broilers. In layer farms, the production in a single flock was 400 to 3000 chicks' minimum and maximum respectively (Table 1). In this survey, the type and production of poultry farms revealed that mostly broiler farms with more production may be attributed to their short cycle, less labor force, less attention and easy management than layer farms.

3.2. Mortality Rate and Flocks Composition. As summarized in Table 1, the average mortality rate was calculated as an average of 6 % and 9 % for broiler and layer farms. Table 1 indicated flock composition for broiler and layer separately across two seasons of the year. During winters, the poultry cycle completes in 40-50 days while in summers; it takes 30-40 days for the broiler. The single flock of layers was completed in 90-120 days in winter and 80-90 days in the summer. An average of 8 flocks per year was raised for broilers and 3 for layers by the selected poultry farms (Table 1).

Different poultry farms showed different mortality rates. The mortality was found higher in the layers in contrast to the broilers because of their delicate nature. These findings are in agreement with observation in Khyber Pakhtunkhwa as revealed by the present study. Similarly, about 8.30 % of birds were lost on every farm in Khyber Pakhtunkhwa¹⁷ and 10 % mortality in Mansehra¹⁸.

Table 1: Type, Production, Mortality and Flock Composition in the Selected Poultry Farms

S. No	Type	No.		No. of chicks	Mortality Rate (%)	Flock Completion (days)		Annual flocks
						Winter	Summer	
1.	Broiler	63	Min	500	4	40	30	7
			Max	4500	7	45	40	9
			Avg	1550	6	42	35	8
2.	Layer	10	Min	400	6	90	80	1
			Max	3000	10	120	90	4
			Avg	1500	9	105	85	3

The variation in the number of flocks was reported in the selected poultry farms. The broiler farmers kept an average of five flocks per annum¹⁸. This is at variance with the findings of¹⁷ who reported 4.97 flocks are kept per year in four districts of Khyber Pakhtunkhwa. This variance may be due to the reason that the selected farms were small scale; duration between flocks was very less and also financially affordable in case of loss.

In discussions with poultry concerns, it was observed that the poultry farming is depending on season. During the extreme season of summer (July and August) and winter (December and January), selected layer farms experienced a delay in farm activities. As a result, flocks of layers are being reduced as compared to broilers annually. The recent observation goes in support of¹⁷. They also reported that farm activities suspended in extreme seasons.

3.3. Type and Thickness of Bedding Material. It was found that 95% of the broiler houses used ricehull, while only 5% utilized sawdust as bedding material. 92% of the layer houses used ricehull, while rest of 8% utilized sawdust as bedding material as given in Table 2.

Table 2: Type and Thickness of Bedding Material

S. No	Type of farms	Ricehull (cm)				Sawdust (cm)			
		No of farms	Max	Min	Avg	No of farms	Max	Min	Avg
1.	Broiler	57	08	05	06	03	07	05	06
2.	Layer	12	07	05	06	01	07	05	06

In response to a question related to bedding, poultry farm operators generally use ricehull and sawdust as bedding materials in the selected area. the farmers told that sawdust and ricehull are better for poultry farming as compared to wheat straw and other materials because of their fine texture. Moreover, wheat straw is cheaper and more easily accessible but is hard. Sometimes small chicks ingest this material, which may damage their digestive tracts. Therefore, wheat straw has not been commonly used. The use of sawdust for bedding in Peshawar, Pakistan was also reported by¹⁹. The literature showed that the selection of suitable bedding material is an important aspect to avoid harmful impacts of raw litter²⁰.

In response to a question about the thickness of bedding material, respondents showed that an average of 06 cm layer of bedding material was used in each poultry farm (Table 2). The bedding material was distributed evenly throughout the farm. A layer of 10-15 cm bedding material was reported by²¹. The bedding material was added from time to time in the poultry houses. The poultry farmer told that with time, bedding material becomes hard and creates problems for chick's movement. So, most of the broiler farms added bedding material twice in each flock, whereas in layer farms bedding material added after four weeks in the first month and after two weeks in the next three months.

3.4. Litter Quantity. Findings from the results showed that at the end of each poultry cycle, a total of 112,500 chicks (93,000 broilers and 19,500 layers) were raised per flock by selected poultry farms. In addition, 4650 and 1365 dead broiler and layer were produced respectively (Table 3).

Table 3 revealed that at the end of each poultry cycle, total litter was 56297 kg in 60 broiler farms and 29511 kg in 13 layer farms. Therefore, the total poultry litter production would be 85808 kg from selected farms. Based on these above findings, 60 broiler farms generated 533340 kg and 13 layer farms generated 85426 kg of poultry litter in one year. Thus, total annual poultry litter production would be 618766 kg that was 0.02 kg/chick/day (Table 3).

The results from this study showed that layer farms generated a less amount of litter than broiler farms. The reason may be the less production and late growth of layers as compared to broilers. These finding was comparable to ¹⁴. They assessed the waste generation was less in layers as compared to the broilers. The similar finding was found by ¹⁷ that an average broiler litter production was about 0.02 kg/chick/day. In contrast to this study, 0.1 kg/chick/day of litter production was reported by ²².

Table 3: Production of Chicks and Generation of Poultry Litter in the Selected Poultry Farms

S.No	Type	No.		Total No. of Chicks	No. of Live Chicks	No. of Days	Litter (kg) (dry weight)
1.	Broiler	60	Flock	93000	88350	38	56297
			Annual	744000	706800	360	533340
2.	Layer	13	Flock	19500	18135	95	29511
			Annual	58500	54405	275	85426
3.	Total	73	Flock	112500	106485	133	85808
			Annual	802500	761205	635	618766

3.5. Poultry Litter Disposal and Use. The responses of the respondents about poultry litter disposal were tabulated in Table 4. A huge quantity of raw litter (84 %) was directly purchased by the farmer only a little portion (16 %) was stored and then transported to agriculture land. The direct use of raw litter is considered improper. The literature also reported the potential negative impacts of raw litter after application on agricultural land and the environment ¹. The main reason found behind direct use was the unconsciousness and unawareness of farmers.

Table 4: Comparative Status of Poultry Litter storage Procedures

S. No	Poultry farm		Litter disposal		Storage		Time (months)
	Type	No.	Store	Farm land	Open dump	Specific site	
1.	Broiler	60	8	52	8	0	14
2.	Layer	13	4	09	4	0	18
3.	Total	73	12	61	12	0	14-18

In response to the questions about the storage time, it was revealed that broiler producers typically store litter for 14 months while layer producers store litter for 18 months (Table 4). It was concluded that broiler farms had a huge amount of litter because of space issues they sold out as soon as possible. Whereas the amount of waste was less in layers and their next flock took time to complete, therefore taking longer to store. These findings were in favor of ⁵ that the farmer's stored poultry litter openly for 8 – 12 months before applying it to the agriculture fields.

This study also investigated that there was not even a single farm with appropriate and planned storage. 100 % of poultry litter is stored openly within the premises of farm areas. This finding is consistent with previous report of ²³. According to them, 90 % of the litter was stored openly that was inappropriate and crucial for the environment. The possible effects of open storage of the poultry litter

have been also reported by ^{24,5}. The open-air storage leads to unpleasant smell, emission of toxic gases and the loss of essential nutrients. The sustainable waste management needs proper storage and treatment facilities to maintain the quality of litter for use as fertilizer and prevent potential environmental hazards ¹².

3.6. Poultry Litter for Crop Production. The results presented in Table 5, the percentage difference showed 35 % increase in the raw litter users than stored litter users. The typical application rates were an average of 4448 kg/hectare for stored poultry litter users and 5436 kg/hectare for raw litter users. 20 % less quantity of stored litter was applied as compared to raw litter. A 21 % increase in the production of the crop was observed with the application of store litter (Table 5).

Table 5: Distributions of Respondents According to Type and Quantity of Litter Users For Wheat Production

S. No	Type of litter	Users	Quantity of litter (Kg) / hectare			Wheat production (Kg) / hectare		
			Min	Max	Avg	Min	Max	Avg
1	Stored Litter User	14	3707	4942	4448	1977	2768	2372
2	Raw Litter User	20	4448	6176	5436	1483	1977	1927
3	Percent Difference	35%	19%	22%	20%	29%	33%	21%

This study investigated that mostly farmer's used raw litter for wheat crop production than stored litter.

They were with the view that raw litter is easily accessible for them as compared to stored litter. The past literature revealed the potential effects for the crop related to raw litter application ⁴. Poultry litter has detrimental potential impacts on the environment but if litter is managed properly it may be an asset to the farmers. The literature also realized that the farmers who depend on stored poultry litter get more crop production than raw litter users. The higher production of wheat as observed in this survey is similar to the findings of ²⁵. Their research showed the importance of stored litter as environmental friendly for increasing production of wheat.

4. Conclusions

Questionnaire survey concluded that majority of the poultry farms were associated with broilers activities rather than layers. A slot was found in data related to the quantity of poultry litter. This study revealed that 618766 kg of poultry litter was generated from 73 poultry houses throughout the year. After the completion of each poultry flock, major portion (84%) of poultry litter directly goes to agriculture sector, while remaining (16%) dumped openly in the farm area. These practices of poultry litter disposal were found to be ineffective. Raw litter may have potential negative impacts on agricultural land and the environment while open storage of poultry litter lead to an unpleasant smell, attraction of flies, released toxic gases and reduction of essential nutrients. This study also revealed an increase in wheat production after application of stored litter than raw litter. However, this productivity could also be enhanced by practicing a more suitable method of poultry litter utilization. This will help in savings resources and economy as well as reduce the waste and dependency on inorganic fertilizer in a sustainable way.

5. Recommendations

The poultry farms needs to be monitored for disposal procedures. It is recommended to elaborate and standardize methods to utilized raw litter and stored poultry litter. Therefore, it is important to encourage the use of stored litter to enhance the wheat productivity and find a scientific way for the storage process for protection and conservation of the nutrients and environment. It is therefore recommended to promote awareness among poultry concerns and farmers in order to make poultry litter as safe and effective fertilizer.

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Posouzení drůbežáren na produkci, likvidaci drůbežního steliva a jeho využití jako hnojiva

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Abstrakt

Odvětví drůbeže je rostoucím odvětvím, které celosvětově vytváří obrovské množství drůbežního trusu (odpadu). Tato studie zkoumala současný stav činností drůbeže, postupy likvidace podestýlky a také její účinky na produkci pšenice v okrese Haripur (Pákistán). S ohledem na to bylo provedeno dotazníkové šetření mezi 73 drůbežářskými podniky a 34 farmáři. Respondenti dotazníku odhalili, že 82 % drůbežích farem chovalo brojler, zbývajících 18 % se zabývalo nosnicemi. Drůbežáři používali jako podestýlku rýžové slupky (94 %) a piliny (6 %) s průměrnou vrstvou 6 cm. Celkem bylo chováno 802 500 ptáků, kteří ročně vyprodukovali 618 766 kg drůbežního odpadu. Podle průzkumu bylo zjištěno, že drůbeží podestýlka se používala jako hnojivo na zemědělské půdě. Z tohoto odpadu 84 % majitelů farem prodávalo drůbeží podestýlku přímo (surová podestýlka) farmářům a dalších 16 % ji likvidovalo (doskladnění) v prostorách svých farem. Toto šetření dospělo k závěru, že použití steliva po uskladnění jako hnojiva vedlo k 21% nárůstu produkce pšenice než použití surového steliva, zatímco otevřené skladování produkovalo nepříjemný zápach, přitahovalo mouchy, uvolňovalo jedovaté plyny a redukovalo základní živiny. Doporučuje se proto změnit způsob skladování steliva a jeho aplikaci na zemědělskou půdu, aby se z drůbežního odpadu stalo bezpečné a účinné hnojivo.

Klíčová slova: brojler; hnojivo; vrstva; drůbežářský průmysl; syrové stelivo