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Economics of Poultry Waste Use as a Fertilizer in Sindh Pakistan

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Abstract

Poultry sector provides quality products that are purchased by vast population in Pakistan. It contributes 6.6% in agriculture by generating employment for about 1.8 million people. Due to high cost of synthetic fertilizer and demand of organic food the farmers are more interested to adopt organic farming techniques. Poultry waste which contains large scale accumulation of litter and manure components can be used for crop production with chemical fertilizers as it is less expensive, available nearby farms and a good source of nutrient improvement to restore degraded soils. This study was aimed at examining the existing supply chain of poultry waste in Sindh province based on information collected by visiting the poultry farms and discussions with poultry farm managers or owners about supply practices of poultry waste. In addition, this study was conducted to investigate the yield impacts of poultry waste application as a fertilizer. Hyderabad district was selected as study area and wheat was taken as target crop for conducting study. Linear multiple regression model was applied to examine the yield response of wheat for both farmer groups to different factors of production. Results revealed that farmer's applied poultry waste received more wheat and profits per acre than poultry waste non-users.

Keywords: Poultry; Fertilizer; Poultry waste; Profits; Sindh

Introduction

Poultry is a category of domesticated birds kept by humans for the purpose of collecting their eggs, or killing for their meat or feathers. Poultry also includes other birds which are killed for their meat, such as pigeons or doves or birds considered to be game, such as pheasants. Poultry comes from the French/Norman word poule, itself derived from the Latin word Pullus, which means small animal. Poultry is the second most widely eaten meat in the world, accounting for about 30% of meat production worldwide.

In Pakistan, wheat being the staple diet is the most important crop and cultivated on the largest acreages in almost every part of the country. It contributes 14.4% to the value added in agriculture and 3.0% to GDP. Over the past three decades, increased agricultural productivity occurred largely due to the deployment of high-yielding cultivars and increased fertilizer use. With the introduction of semi-dwarf wheat cultivars, wheat productivity has been increased in all the major cropping systems representing the diverse and varying agro-ecological conditions. Pakistan has been divided into ten production zones because of great agro ecological areas where wheat is grown.

There are specific practices that must be followed to properly maintain the litter maximizes the health and productivity of the flocks raised on it. Many factors must be considered in successful litter management including time of the year, depth of the litter, floor space per bird, feeding practices, disease, the kind of floor, ventilation, watering devices, litter amendments, and even the potential fertilizer value of the litter after it is removed from the house. Most poultry are grown on dirt floors with some type of bedding material. Concrete floors and some specialized raised flooring are used at some facilities. In many areas of the country, shavings from pine or other soft woods have historically been the bedding of choice for poultry production. Regionally, other materials have been the bedding material of choice due to regional cost and availability, such as rice hulls in the lower Mississippi River poultry production areas of Arkansas and Mississippi.

Fertilizer use is an integral part of crop production system and fertilizers are non-poisonous material unlike pesticides. Different types of nitrogenous, phosphate and potassium fertilizers are used in Pakistan for crop production. It is well recognized that fertilizers are essential for the production of food and fiber crops to cater the needs of ever increasing population of the world. Moreover, fertilizers not only help to maintain the fertility and productivity of cultivated lands but also improve the soil quality and intern food production. The involvement of balanced fertilizer use varies from 30 to 60% in different crop production areas of Pakistan. One kilogram of NPK fertilizer generates about 8 kilograms of cereals (wheat, rice and maize), 2.5 kilograms of cotton and 114 kilograms of stripped sugarcane. Agriculture land in Pakistan is lacking in essential nutrients with almost 80 to 90% deficiency in phosphorus and 30% in potassium. In addition to these there is a widespread deficiency of micronutrients in many areas [1].

Poultry is one of the well controlled and lively sectors of agriculture in Pakistan. It plays an important role by providing human food objects like eggs and meat. The income and employment of about 1.5 million people is directly and indirectly subjected to this sector which adds 6.4% in agriculture and 11.5% in livestock growth. 25.8% of total meat production in Pakistan is from poultry sector. Present investment in poultry is about 200 billion rupees with a healthy growth at the rate of 8 to 10% per year, representing its inner potential. Poultry sector contains domestic and commercial poultry. Domestic poultry revolves round cock, hen, chicken and their products like eggs and meat while commercial poultry is more focused to layers, broilers and their products. In addition to the diet items poultry sector is also capable of providing several by products like litter, feathers and fluffs, egg shells and blood which are acquired and utilized as a raw material by different industries [2].

Fertilizers requirements in the country are met from both domestic production and imports. Currently, there are 14 production units with

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a combined design capacity of 233 thousand tons of nitrogen and 239 thousand tons of P_2O_5. The annual production capacity of urea, DAP, SSP and NPK compounds is 4.3 million tons, 450 thousand tons, 180 thousand tons and 5.78 million tons respectively. According to the economic survey 2012, 2255 thousand tones of fertilizer is produced domestically while 1024 thousand tones is imported. Total production is 3279 thousand tons while off-take reaches to 2913 thousand tons [3].

Objectives

1. To explore the existing supply chain of poultry waste.

2. To identify different factors affecting the productivity of wheat in Hyderabad.

3. To identify issues and suggest policy measures for promoting on poultry waste use as Fertilizer in the study area.

Methodology

Primary purpose of this chapter is to explain various tools and techniques in the selection of sample, collection, analysis and interpretation of data relating to research. Intend of this study was to investigate the existing supply chain of poultry waste and its impacts on the yield of wheat in Hyderabad district. Planned strategy was used to study the area, type and number of respondents without which it would be an ineffective effort. Therefore, it is essential to define variables included in the research to make it more scientific and objective [4-10].

Study area

The study was restricted generally to gather primary data from Hyderabad district. Hyderabad district was selected as the universe of the study because it represents a good case study for poultry and crop production activities. A brief description of the study area is Hyderabad well known as the Mango City of. The district is gifted naturally with fertile soil. Canals and tube wells are major source of irrigation. Wheat, sugarcane, cotton, and vegetables are the major crops grown in the area [11-15].

Due to small land holding most of people are connected to mixed farming. Poultry farming has become an organized industry over the years and has got the attentions of farmers having small or large land holding due to high scope of income and rising prices of poultry meat and eggs [16-20].

Farmers now days, grow cash crops like wheat and build poultry farms on their land to generate extra income and fulfill daily household requirements of eggs and meat. Poultry farms are generally located in the surroundings of urban areas due to easy availability of input supplies, markets and reasonable output prices [21-25].

Regression analysis

Regression analysis is a statistical procedure for estimating the relationship between variables. Main focus of this technique is to find out the relationship among a dependent variable and one or more independent variables.

In order to achieve the objective of different factors contributing to the yield of wheat including poultry waste as a fertilizer, regression analysis was conducted [26-30].

According to the nature of study linear multiple regressions was adopted due to the following features:

1. Authentication and reliability with the theory and logic of study.

2. The size of coefficient of multiple determination (R-square)

3. Statistically significant "T" and "F" values.

Linear multiple regression is the best option on the basis of R-square, F ratio, Standard error and T values of the variables.

In this present study, following regression model was used to estimate the impacts of various factors on the yield of wheat.

$$Y = \alpha + \sum_{i=1}^{n} (bi\ Xi) + \mu_i$$

Y= Dependent variable

α= Intercept

bi = Regression coefficient

Xi= Independent variables

i = (1, 2, 3, ……, n)

μ¡= error term

$$\mathbf{Y}= \alpha+ \boldsymbol{b}_1(X_1)+ \boldsymbol{b}_2(X_2)+\boldsymbol{b}_3(D_1)+\boldsymbol{b}_4(D_2)+\boldsymbol{b}_5(X_3)+\boldsymbol{b}_6(X_4)+\boldsymbol{b}_7(D_3)+\boldsymbol{b}_8(X_5)+\boldsymbol{b}_9(X_6)+ \mu$$

Or,

$$\mathbf{Y}= \alpha+\boldsymbol{b}_1(LPC)+\boldsymbol{b}_2(SR)+\boldsymbol{b}_3(ST)+\boldsymbol{b}_4(SM)+\boldsymbol{b}_5(Irri)+\boldsymbol{b}_6(NP)+\boldsymbol{b}_7(PW)+\boldsymbol{b}_8(PPC)+\boldsymbol{b}_9(LC)+\mu$$

Where,

Dependent variable

Y = yield of wheat (mounds per acre).

Independent variables

Land Preparation Cost

LPC = per acre Land preparation cost.

Seed Rate

SR = in terms of Kilograms per acre.

Seed Type

ST= 1 if seed was purchased from any certified source, otherwise taken as 0.

Sowing Method

SM = 1 if drill method was used and 0 if seed is sown by broadcast method.

Irrigation

Irri = Number of irrigations applied per acre.

Chemical Fertilizer

NP = Nitrogen + Phosphorus applied in Kilograms per acre.

Poultry Waste

PW =1 if poultry waste is applied as a fertilizer in wheat, otherwise taken as 0 (if not applied).

Plant Protection Cost

PPC =per acre cost of Weedicides and Pesticides applied to wheat crop.

Labor Cost

LC = Taken in terms of cost per acre of labor used in various farm operations.

Although there are a large number of variables that influence the yield of wheat like tenure system, credit availability, cropping intensity, crop rotation, farm yard manure etc. these factors are important but excluded to maintain the consistency and viability of the study due to statistical problems in the assessment of model [31-35].

Results

Analysis and interpretation of data are essential part of the social scientific research. Without these objectives of the research cannot be achieved as they provide assistance in generalization and predictions. Intention of the study was to explore the supply chain of poultry waste and to identify different factors affecting the productivity of wheat including poultry waste, as a fertilizer in Hyderabad district. This chapter has been divided into four sections. The first section represents the socio economic characteristics of sample respondents. In second section, economic analysis of the wheat crop is provided with the information including both poultry waste users and non-users. In third section regression analysis results of factor's impact on the yield of wheat are expressed for both farmer groups and in the forth section supply chain of poultry waste is discussed according to the gathered information from poultry farmers [36-40].

Age of farmer

In Table 1, it indicates that majority 70.00% of Poultry waste non-users belonged to the age group of 25-45, 16.66% were less than 25 years and 13.33% were more than 45 years of age . Majority 63.33%of Poultry waste users also belonged to the age group of 25-45, only 20.00%were less than 25 years and 16.66% were more than 45 years of age.

Education of farmer

In Table 2, it Shows that Poultry waste non-users there were 23.33% were illiterate, 33.33% primary and 33.33% were middle/matric education. 6.66% were intermediate and only 3.33% was Graduation/ Master. While in case of Poultry waste users were 16.66%were illiterate, 23.33%primary and 43.33%were middle/matric education. 10.00%were intermediate and only 6.66% was Graduation/ Master.

Marital status

In Table 3, it shows that Poultry waste non-users there were 30.00% were single marital status, 66.66% were married marital status, and 3.33% were widow. 0.00% was divorced. While in case of Poultry waste users were 33.33% were single marital status, 40.00% were married marital status, and 6.66%were widow. Only 3.33% were divorced.

Family size of the farmer

In Table 4, it shows that Poultry waste Non-users there were 33.33% were less 5 members, 26.66% were 5-8 members, 23.33% were 8-10 members farm size. Only 16.66% were above 10 member farm size while in case of Poultry waste users were 30.00% were less 5 acres, 23.33 were 5-8 members, 26.66% were 8-10 member farm size. Only 20.00% were above 10 acres farm size.

Age of Farmers	Poultry waste Non-users		Poultry waste Users	
	No. Respondent	Percentage	No. Respondent	Percentage
Bellow 25	05	16.66	06	20.00
25-45	21	70.00	19	63.33
Above 45	04	13.33	05	16.66
Total	30	100.00	30	100.00

Table 1: Distributions of respondents according to age of farmer in the study area.

Education of Farmers	Poultry waste Non-users		Poultry waste Users	
	No. Respondent	Percentage	No. Respondent	Percentage
Illiterate	7	23.33	5	16.66
Primary	10	33.33	7	23.33
Middle/ Matric	10	33.33	13	43.33
Intermediate	2	6.66	3	10.00
Graduation/ Master	1	3.33	2	6.66
Total	30	100.00	30	100.00

Table 2: Distribution of respondents according to education of farmer in the study area.

Marital Status	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Single	9	30.00	10	33.33
Married	20	66.66	12	40.00
Divorced	0	0.00	1	3.33
Widow	1	3.33	2	6.66
Total	30	100.00	30	100.00

Table 3: Distributions of respondents according to marital status in the study area.

Family Size of Farm	Poultry waste Non-users		Poultry waste Users	
	No. Respondent	Percent	No. Respondent	Percent
Less 5 member	10	33.33	9	30.00
5-8 member	8	26.66	7	23.33
8-10 member	7	23.33	8	26.66
Above 10	5	16.66	6	20.00
Total	30	100.00	30	100.00

Table 4: Distributions of respondents according to family size of the farmer in the study area.

Family type

In Table 5, it shows that non-borrowers there were 46.66% were joint family system, 10.00% were extended family type and 43.33% were single family type. While in case of borrowers were 53.33% were joint family system, 6.66% were extended family type and 40.00% were single family type.

Land use status

In Table 6, it shows that Poultry waste Non-users there were 46.66% were owner ship, 30.00% were tenant farmers and 23.33% were owner cum tenant respondents. While in case of Poultry waste users were 53.33% were owner ship, 26.66% were tenant farmers and 20.00% were owner cum tenant respondents.

Size of landholding of the farmer

In Table 7, it shows that Poultry waste Non-users there were 33.33% were less 5 acres, 26.66% were 5-8 acres, 23.33% were 8-10 acres farm size. Only 16.66% were above 10 acres farm size while in case of Poultry waste users were 30.00% were less 5 acres, 23.33 were 5-8 acres, 26.66% were 8-10 acres farm size. Only 20.00% were above 10 acres farm size.

Production technology of wheat crop

Production technology of wheat includes all the procedures adopted by the farmers to grow crop i.e. land preparation, seed rate and type, sowing method, fertilizers both organic and inorganic, number of irrigations applied and plant protection measures. This section describes the production technology used by two groups of farmers for wheat crop for season 2014.

Family Type	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Joint	14	46.66	16	53.33
Extended	3	10.00	2	6.66
Single	13	43.33	12	40.00
Total	30	100.00	30	100.00

Table 5: Distribution of respondents according to family type in the study area.

Land Use Status	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Owner	14	46.66	16	53.33
Tenant	9	30.00	8	26.66
Owner cum Tenant	7	23.33	6	20.00
Total	30	100.00	30	100.00

Table 6: Distributions of respondents according to farmer status in the study area.

Size of Land holding (Ares)	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Less 5 acres	10	33.33	9	30.00
5-8 acres	8	26.66	7	23.33
8-10 acres	7	23.33	8	26.66
Above 10 acres	5	16.66	6	20.00
Total	30	100.00	30	100.00

Table 7: Distributions of respondents according to Size of Landholding (acres) in the study area.

Number of ploughs

In Table 6, it shows Number of ploughs are separated into further categories; up to 4 and above 4. It is clear from the table that poultry waste non-users had greater number of farmers (30); applying up to 4 numbers of ploughs per while 19 poultry waste users and 22 non-users. Second category of above 4 contained fewer respondents from both farmer groups with 11 poultry waste users and 8 non-users.

Seed type and rate

In Table 7, it is clear that 76.66%% poultry waste users and 80.00%% non-users applied own seed from the previous harvest. On the other hand, 23.33%% poultry waste users and 20.00%% non-users bought certified seed from the market.

In Table 8 it is evident that poultry waste users and non-users applied an average of 52.42 kg and 51.33 kg seed per acre respectively. Though, there is not a very large difference in average seed used by both farmer groups but the later used less quantity of wheat seed per acre to some extent.

Sowing time

In Table 9, it is clear that 86.66%% poultry waste users and 76.66%% non-users sown wheat timely. On the other hand, 13.33%b% poultry waste users and 23.33%% non-users sown wheat late.

Sowing method

In Table 10, it is clear that of poultry waste users adopted broadcast method to cultivate wheat followed by 66.66%% poultry waste users and 80.00%% non-users. Drill method was adopted by poultry waste users 33.33% and non-users 20.00%.

Use of chemical and fertilizers

In Table 11, it shows the average quantity of fertilizers applied by two groups of farmers (Poultry waste users and non-users) on wheat crop. Farmer poultry waste non-users applied 1.89 urea bags per acre which was greater than the poultry waste users having an average of 1.71 bags per acre. For DAP fertilizer. Both farmer groups individually applied 1.09 and 1.27 DAP bags per acre respectively. Other fertilizers were used in miner quantities by all the farmers as it is clear from table that only poultry waste non-users applied these fertilizers with an average of 0.05 bags per acre. On the whole it is illustrated that poultry waste non-users applied more chemical fertilizers than poultry waste users.

Use of nitrogen and phosphorus

In Table 12, it is evident that poultry waste non-users applied greater amounts of nitrogen and phosphorus per acre than users. Average nitrogen applied by poultry waste users and non-users was 51.53 and 54.68 kilograms per acre. Phosphorus used by both farmer groups was 25.07 kilograms for poultry waste users and 29.44 kilograms for non-users per acre. On the whole, average 76.60 and 84.12 kilograms N+P was applied by poultry waste users and non-users kilograms per acre respectively.

Poultry waste as a fertilizer

In Table 13, illustrates the average use of poultry waste by poultry waste users. Only one group of farmers used poultry waste on an average of 0.91 trolleys and 24.85 mounds per acre.

Ploughs / Acre	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Up to 4	22	73.33	19	63.33
Above 4	8	26.66	11	36.66
Total	30	100.00	30	100.00

Table 8: Distributions of respondents according to size of landholding (acres) in the study area.

Seed Type	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Own	24	80.00	23	76.66
Buy	6	20.00	7	23.33
Total	30	100.00	30	100.00

Table 9: Distributions of respondents according to seed type used by farmer in the study area.

Seed Rate	Farm Category	
	Poultry waste Non-users	Poultry waste users
Average (Kg/acre)	52.42	51.33

Table 10: Seed Rate applied by Farmer Groups in the study area.

Sowing	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Timely	23	76.66	26	86.66
Late	7	23.33	4	13.33
Total	30	100.00	30	100.00

Table 11: Distributions of respondents according to sowing time of farmer in the study area.

Sowing Method	Poultry waste Non-users		Poultry waste users	
	No. Respondent	Percent	No. Respondent	Percent
Broadcast	24	80.00%	20	66.66%
Drill	6	20.00%	10	33.33%
Total	30	100.00%	30	100.00%

Table 12: Distributions of respondents according to sowing method by farmer in the study area.

Average cost of wheat production

In Table 14, illustrates the average cost of different procedures adopted in the production of wheat. This table shows the average cost of production incurred by all the sample respondents in study. Increase in the petroleum prices as compared to preceding years had their impacts on the cost of inputs. The table indicates that average land preparation (ploughing and seed bed preparation) cost was Rs. 3578.38 per acre with a fraction of 14.28% of the total cost. Cost for sowing process, which contained drilling cost was only Rs. 207.35 per acre and it was just 0.83% of the total because of the fact that more farmers applied broadcast method to sow wheat instead of drilling. Average per acre cost for seed was the Rs. 1457.50 and it was 5.81% of the total cost of production. Fertilizers both chemical and poultry waste accounted for major proportion (35.42% of the total cost) in the production cost of wheat. Average cost of chemical and poultry waste fertilizer separately was Rs. 8376.31 (33.42%) and Rs. 439.06 (1.75%) per acre respectively. Differences in the price of poultry waste were due to handling, transportation and availability of poultry waste. Weedicides and pesticides were applied as plant protection measures and they cost Rs. 1060 per acre with a proportion of 4.23% of the total cost incurred. Irrigation was the 2nd major contributor (17.45%) to the total cost of wheat production as it was Rs. 4375 per acre. Harvesting made up 12.39% of the total production cost with an average of Rs. 3106 per acre. Cost of hired labor was Rs. 2466.25 per acre on average contributing 9.84% to the total per acre cost. On the whole, total average cost per acre of wheat production by all the sample farmers was Rs. 25065.86. Most of the farmers experienced higher costs of inputs than the previous years because of higher fuel prices and lack of own farm machinery.

Per acre production

In Table 15, it shows per acre average cost of wheat production is discussed among poultry waste users and non-users. It is shown in the table that the cost of land preparation, seed, plant protection and labor were higher among poultry waste users as compared to non-users. Poultry waste users also incurred extra average amount of Rs. 616.96 with a fraction of almost 3% to the total user's cost. It was described in table that poultry waste non-users applied more chemical fertilizers than users so their average cost of chemical fertilizer was much higher than poultry waste users which was recorded as Rs. 8586.25 making a proportion of 34.96% the total non-user's cost. In addition to these, irrigation and harvesting cost of poultry waste non-users were also higher than users. On the whole, the average total cost of wheat production was greater among poultry waste users (Rs. 25375.95) per acre as compared to non-users who incurred Rs. 24758.99 per acre in this concern.

Fertilizer	Poultry waste Non-users	Poultry waste users
	No. Fertilizer Bags/per acre	No. Fertilizer Bags/per acre
Urea	1.89	1.71
DAP	1.27	1.09
Others	0.05	0

Table 13: Average quantity of fertilizer used by farmer in the study area.

Fertilizer	Poultry waste Non-users	Poultry waste users
	No. Fertilizer Kgs/per acre	No. Fertilizer Kgs/per acre
Nitrogen (N)	54.68	51.53
Phosphorus (P)	29.44	25.07
Total(N+P)	84.12	76.60

Table 14: Average nitrogen and phosphorus used by farmer in the study area.

Fertilizer	Poultry waste Non-users	Poultry waste users
	No. Fertilizer Bags/per acre	No. Fertilizer Bags/per acre
Urea	1.89	1.71
DAP	1.27	1.09
Others	0.05	0

Table 15: Average use of poultry waste as a fertilizer by farmer in the study area.

Yield and revenue and gross margin of wheat production

In Table 16, it shows the revenue gained by two farmer groups i.e. poultry waste users and non-users. In the table it is clear that poultry waste users had greater average per acre wheat productivity of 41.87 Mds per acre as compared to non-users (1 mound = 40 kg). The average per acre revenue of poultry waste users and non-users was Rs. 50460.62 and 47952.75 respectively. Table also illustrates the gross margin (total revenue - total cost) of poultry waste users and non-users on individual and overall basis. It is evident from the table that poultry waste users had greater average per acre gross margin of Rs. 25084.67 as compared to non-users (Rs. 23193.76 per acre). Description of Variables included in the analysis. The objective is to summarize the main features and variables included in data analysis. This summary can also be called as descriptive statistics. Descriptive statistics gives the quantitative explanation of main features of the study. It explains what is in data. Researchers are helped to draw mean, variance, standard deviation and minimum and maximum quantities of variables they are working on

Variables

In Table 17, Statistics for the whole variable analysis represent that the mean, standard deviation and variance of irrigation was 3.95, 0.456 and 0.208 respectively. Minimum 3 and maximum 5 numbers of irrigations were applied by all sample respondents. Cost applied to prepare land for wheat cultivation had a mean of 3578.38 with standard deviation 552.659 and 305432.4 variance. Minimum and maximum costs incurred per acre on land preparation ware Rs. 2350 and Rs. 4550. Statistics for sample shows that mean value of wheat seed applied by the farmers was 51.88 kg per acre. Standard deviation and variance for seed was 0.402 and 0.162 respectively. Minimum 50 kg per acre and maximum 60 kg per acre seed was applied in wheat production. Standard deviation and variance of chemical fertilizer (NP), as described by the sample was 13.996 and 195.889 respectively with the mean value of 81.8 kg per acre. Minimum 55 kg per acre and maximum 110 kg per acre NP was applied by the sample farmers. Mean, standard deviation and variance values were 1060, 525.959 and 276633.6 respectively. Poultry waste which was applied by only by half of the sample respondents to examine its impact on wheat yield of poultry waste users had a mean of value of 0.913. Minimum and maximum trolleys of poultry waste per acre were 0.5 and 1.5 respectively. It had a variance of 0.067 and standard deviation was 0.259. Minimum cost incurred on plant protection was Rs. 0 while the maximum cost was Rs. 2000 per acre. Labor cost had the mean value of Rs. 2466.25. Standard deviation and variance of labor cost were Rs. 530.101 and Rs. 28107.0. Its minimum value was 0 and maximum value was 3500. Statistics for the whole sample analysis shows that mean value for wheat yield per acre was 40.95. Minimum and maximum values were 35 and 48 respectively. The standard deviation and variance for the yield per acre was 2.319 and 5.376 respectively.

Multiple linear regression analysis

Multiple linear regression technique was applied to observe the relative significance of independent variables in determining the dependent variable. Beta (β) tells the relative importance of independent

variables for the yield of wheat. It determines the change in dependent variable as a result of one unit increase in the dependent variables. Multiple coefficient (R-square) was applied to estimate the goodness of fit of the model. It clarifies how well independent variables explained the dependent variable. Table 17 illustrates the results of regression analysis. It holds standard errors and standardized regression coefficients. It is clear from the table that the independent variables which influenced the yield of wheat i.e. No. of irrigations, Land preparation cost, Seed type, Sowing method, Seed rate, Chemical fertilizers, Poultry waste, Plant protection cost and labor cost have regression coefficients of 0.454, 0.001, 0.579, 0.756, 0.090, 0.042, 1.644, 0.004 and 0.001 respectively. All variables were significant except No. of irrigation, and seed rate. The adequacy of model is determined by looking some features of model like R-square and F-value, which are both significant statistically. R-square (0.499) which specifies that all the independent variables included in the model were responsible for explaining 49.9% of the variation in the yield of wheat (dependent variable). In economic research, a model is considered to be best fit if it contains greater than 0.4 R-square. While F-value of the model expresses the overall significance of model. Its value tells the significance and non significance of all the variables whether they produce the changes in dependent variables or not. The F-value of the model was 12.17535 ($p<0.05$) which is highly significant and show the good fitness of model [41-50].

Hence the model determining the yield impact of different variables on the yield of wheat is:

$$Y = \alpha + 0.001(X_1) + 0.090(X_2) + 0.579(D_1) + 0.756(D_2) + 0.454(X_3) + 0.042(X_4) + 1.644(D_3) + 0.004(X_5) + 0.001(X_6) + \mu$$

Linear regression

In Table 18, it illustrates the results of regression analysis. It holds standard errors and standardized regression coefficients. It is clear from the table that the independent variables which influenced the yield of wheat i.e. No. of irrigations, Land preparation cost, Seed type, Sowing method, Seed rate, Chemical fertilizers, Poultry waste, Plant protection cost and labor cost have regression coefficients of 0.454, 0.001, 0.579, 0.756, 0.090, 0.042, 1.644, 0.004 and 0.001 respectively. All variables were significant except No. of irrigation, and seed rate. The adequacy of model is determined by looking some features of model like R-square and F-value, which are both significant statistically. R-square (0.499) which specifies that all the independent variables included in the model were responsible for explaining 49.9% of the variation in the yield of wheat (dependent variable). In economic research, a model is considered to be best fit if it contains greater than 0.4 R-square. While F-value of the model expresses the overall significance of model. Its value tells the significance and non significance of all the variables whether they produce the changes in dependent variables or not. The F-value of the model was 12.17535 ($p<0.05$) which is highly significant and show the good fitness of model.

Hence the model determining the yield impact of different variables on the yield of wheat is:

$$Y = \alpha + 0.001(X_1) + 0.090(X_2) + 0.579(D_1) + 0.756(D_2) + 0.454(X_3) + 0.042(X_4) + 1.644(D_3) + 0.004(X_5) + 0.001(X_6) + \mu$$

Farm Operations	Cost per Acre (Rs.)	Percentage of Total Cost
Land Preparation (Ploughing + Seed Bed)	Rs.3578.38	14.28
Sowing (Drilling)	Rs. 207.35	0.83
Seed	Rs. 1457.50	5.81
Chemical fertilizer (NP)	Rs. 8376.31	33.42
Poultry waste cost	Rs. 439.06	1.75
Plant Protection (Weedicides + Pesticides)	Rs. 1060	4.23
Irrigation	Rs. 4375.00	17.45
Harvesting	Rs. 3106.02	12.39
Labor	Rs. 2466.25	9.84
Total Cost Rs.	Rs. 25065.86	100.00

Table 16: Average cost of wheat production per acre in the study area.

Farm Operations	Poultry waste Users		Poultry waste Non Users	
	Cost per acre (Rs.)	Percentage	Cost per acre (Rs.)	Percentage
Land Preparation	3596.50	14.17	3560.25	14.38
Sowing	210.00	0.83	207.92	0.84
Seed	1486.67	5.86	1428.33	5.77
Chemical fertilizer	8166.38	32.18	8586.25	34.68
Poultry waste cost	878.13	3.46	0.00	0.00
Plant Protection	1096.67	4.32	1023.33	4.13
Irrigation	4312.50	16.99	4437.50	17.92
Harvesting	3096.67	12.20	3115.36	12.58
Labor	2532.44	9.98	2400.06	9.69
Total Cost Rs.	25375.95	100.00	24758.99	100.00

Table 17: Average cost of wheat production per acre by farmer in the study area.

Wheat/acre	Poultry waste Users	Poultry waste Non Users
Grain Yield (Mds)	41.87	39.92
Price per Mds	960.25	958.50
Wheat Straw (Mds)	41.87	39.92
Price per mound	245	240
Revenue	50460.62	47952.75
Cost	25375.95	24758.99
Gross Margin	25084.67	23193.76

Table 18: Yields and revenue of wheat crop for farmer in the study area.

Conclusion and suggestions

Increase in the cost of chemical fertilizers along with decreasing non renewable plant nutrient resources called for organic farming which is the best option these days for producing healthy, good quality and low priced agriculture products to fulfill household requirements more over attracting international market. Organic farming is not only an important alternative to chemical fertilizers but also decreases the environmental hazards of waste accumulation.

An increasing demand of poultry products is noticed during last few years which have resulted in an urge to grow poultry farming industry. Present investment in poultry is about 200 billion rupees with a healthy growth at the rate of 8 to 10% per year, representing its inner potential. Rapid growth in poultry sector generates large quantities of poultry waste around the world every year. Large-scale accumulation of these wastes may cause sewerage and pollution problems. Therefore, economic and environmentally feasible utilization of poultry waste is very important.

Most of the manure and litter produced by the poultry industry is currently applied to agricultural land. The availability of essential nutrients like nitrogen (N), phosphorus, potassium and other micronutrients makes it a best option to be used as a fertilizer source. The present study was attempted to examine the impact of poultry

waste as a fertilizer in Faisalabad district. The impact of poultry waste use on wheat crop yield was examined. There is no study conducted on poultry waste application as a fertilizer in the region. Therefore, the study tries to fulfill the academic gap in the area.

A sample size of 60 respondents was selected purposively consisting of respondents applying poultry waste as a fertilizer along with chemical fertilizers and 30 respondents who were not applying poultry waste. Detailed data on different aspects of the respondents was taken through a well-structured questionnaire in a face-to-face interview.

Regression analysis was used as a technique of analysis to investigate the factors contributing to the yield variability of wheat. The important factors affecting the yield of wheat were land preparation cost, irrigation, fertilizer seed rate, sowing method, seed type, labor cost and plant protection measures.

Conclusions

The effect of poultry waste on wheat yield was analyzed on the basis of data gathered from two farmer groups (poultry waste users and non-users). From the results presented we conclude that

- Poultry waste is a good organic source of nutrients for raising crops, such as wheat. Crop productivity is believed to increase by poultry waste application as a fertilizer due to its nutrient composition and availability. In case of Pakistan, where prices of chemical fertilizers are increasing day by day, poultry waste is a best option to gain better yield results.

- Poultry waste application brought higher yields to poultry waste users with comparatively low amounts of chemical fertilizers applied than poultry waste non-users.

- Higher rates of returns in terms of revenue and overall increase in gross margins can be achieved due to better plant growth impacts of poultry waste.

- Variables involved in the study like land preparation cost, sowing method, chemical fertilizers, plant protection cost, labour cost and poultry waste showed significant effect on yield. Poultry waste had most significant effect on the yield of wheat with highly significant behaviour ($p<0.05$) and coefficient value of 1.644.

Recommendations

The findings based on the study have important policy implications which can guide the government towards poultry waste utilization in Pakistan.

- Poultry waste causes considerable emissions such as nitrates, phosphates and heavy metals held liable for excess nutrients in surface and ground water source. It must be made sure by the poultry farmers that the storage places of poultry waste are not much close to the drinking water source.

- Better management of poultry waste is the only way to reduce its negative impacts on humans and environment, so environment friendly management techniques should be adopted at least lining of storing places of litter and manure and covering of poultry waste must be done to reduce leaching and run off.

- Management of poultry waste incurs additional cost to the dairy farmers and cost of some management practices are much high like biogas production of poultry manure. Government should encourage poultry farmers by loans to adopt better management practices.

- Most of the farmers do not take poultry waste a hazard to the nature and human health. There is a lack of knowledge on the airborne transmission of infectious agents such as virus and microorganisms from farm. So there is also a need to educate poultry farmers of the negative and harmful impacts of poultry waste.

- Government should conduct more feasibility studies on the efficient allocation of poultry waste which can be proved as a nutritious, relatively cheap and a quality resource for plant production.

- Excess application of poultry waste to the agriculture land results in leaching down and runoff of nutrients which can negatively affect the plant growth and yield. Government should take initiatives to aware farmers about the balanced application of poultry waste to the field and must sustain balance between crop intake and poultry waste application level.

- In the field, poultry waste due to bulky in nature is not equally distributed and applied in forms of heap or with irrigation water such application methods increase concentration of nutrient level on specific place and result in leaching down to ground water. In order to avoid it poultry waste should be applied evenly to the fields.

- In developed countries, poultry waste is used as a fuel source to generate power and energy. Pakistan, which is facing huge energy crisis in the present time should take advantage of this abundantly available resource and should find ways to generate power from this source.

- Government, environmental agencies and farmers should work in collaboration too achieve all these objectives to protect human health and environment.

Variables	Units	Frequency	Min	Max	Mean	Standard Deviation	Variance
Land Preparation	Rs.	120	2350	4550	3578.38	552.659	305432.4
Seed	Kg.	120	50	60	51.88	0.402	0.162
Irrigations	No.	120	3	5	3.94	0.456	0.208
Chemical fertilizers (NP)	Kg.	120	55	110	81.1	13.996	195.889
Poultry Waste	Trolley	60	0.5	1.5	0.913	0.259	0.067
Plant Protection	Rs.	120	0	1970	1060	525.959	276633.6
Labor	Rs.	120	0	3500	2466.25	530.161	281071
Yield	Mound	120	35	48	40.95	2.319	5.376

Table 19: Summaries of variables included in the analysis.

Table 20: Multiple linear regression analysis

Variables	Coefficients	Std. Error	t-value	Significance
α = Intercept	22.287	3.368	6.616	0.000
X_1 = Land Preparation cost	0.001	0.000	1.996	0.048
X_2 = Seed Rate	0.090	0.055	1.624	0.107 ^{NS}
D_1 = Seed Type	0.579	0.428	1.351	0.179 ^{NS}
D_2 = Sowing Method	0.756	0.368	2.052	0.042
X_3 = No. of irrigations	0.454	0.359	1.261	0.210^{NS}
X_4= Chemical fertilizer	0.042	0.012	3.35	0.001
D_3 = Poultry waste	1.644	0.332	4.942	0.000
X_5 = Plant Protection cost	0.004	0.002	2.103	0.037
X_6 = Labor Cost	0.001	0.000	2.069	0.040
R-Square	0.499	…….	……..	……..
Adjusted R-Square	0.458	…….	……..	……..
F-Value	12.175	…….	……..	……..

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