On-Farm Agro-Economic Effects of Fertilizing Cropland with Poultry Litter

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Primary Audience: Poultry Producers, Litter Brokers, Farmers, Ranchers, Extension Agents

SUMMARY

The profitability of using poultry litter as a fertilizer and soil amendment in cultivated agriculture was evaluated with the hopes of determining an economically optimal fertilization strategy. The traditional commercial (inorganic) fertilizer practice was compared with several hybrid litter and commercial N fertilization alternatives in terms of on-farm agro-economic effects. Six years of land management, crop yield, crop price, and fertilizer cost data were collected from 6 field sites in central Texas and utilized for economic analysis. Varying litter and inorganic fertilizer combinations resulted in minimal differences in corn and wheat yields; however, total fertilizer costs increased significantly as litter application rate increased (and commercial fertilizer rate decreased) in spite of dramatic cost increases for commercial fertilizer. The greatest average annual profits were determined to occur at the 1 and 2 tons/acre (ac) litter rates with 7 to 14% profit reductions for the commercial fertilizer-only treatment and the 3 tons/ac litter treatment. At litter rates greater than 3 tons/ac, diminishing returns were observed as fertilizer costs increased with no compensating greater yields to provide offsetting revenues. It is important to note that this economically optimal annual litter rate of 1 to 2 tons/ac is also environmentally optimal according to nutrient runoff and soil nutrient data collected on-site. These results provide the scientific basis to support the use of litter as a cost-effective, environmentally friendly fertilizer alternative in this and similar regions.

Key words: by-product utilization, profitability, environmental sustainability, water quality

2008 J. Appl. Poult. Res. 17:545–555
doi:10.3382/japr.2008-00039

DESCRIPTION OF PROBLEM

The shift to expanded confined animal operations, including poultry operations, has led to localized excesses of manure and wastewater by-products, which has created the potential for environmental degradation if these wastes are not properly managed [1, 2]. This situation can also, however, increase the availability of by-products for use as organic fertilizers, which may provide farmers an economically and environmentally viable alternative to commercial (inorganic) fertilizer [3]. Where such conditions exist, environmental issues of soil and water quality degradation and economic issues of by-product disposal costs for the animal industry and alternative fertilizer sources for the agricultural producer are significant. As public and reg-

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ulatory pressure mount to determine economically and environmentally sustainable waste management practices, so will the importance of determining appropriate animal by-product utilization practices [4].

Studies such as those of Gburek and Sharpley [5] and Haggard et al. [6] measured nutrient losses in stream flow from mixed land use watersheds in which animal manures had been applied. Their results indicated the importance of proper organic fertilizer management to limit excess nutrient loss to surface water, especially in areas with high soil P concentrations, high runoff rates, or both. Generally speaking, environmental harm related to manure application largely results from application in excess of agronomic rates [1, 3]. Kaplan et al. [7] explored the sector-wide, regional, and national effects of constraining manure application on-site at animal feeding operations. The economic effects on animal and crop production and environmental effects in terms of N and P loss were variable and depended on regional land use and production tendencies. These results emphasize the importance of on-farm decision-making, both on-site at production facilities and off-site at land application fields, where management practices are typically implemented.

Land application is the most common, and usually most desirable, method of utilizing manure because it provides beneficial nutrients and organic matter [8]; however, on-site application fields in many regions are reaching agronomic or regulatory thresholds for soil P [9–11]. Thus, increasing amounts of litter are being distributed off-site to conventional farm and ranch operations. On these off-site (third party) application sites, the major difficulty is determining the most efficient fertilizer strategy by balancing cost, nutrient value, soil enhancement, and environmental effect [12, 13].

In 2000, a comprehensive long-term study was initiated to determine this balance in central Texas [14]. That study evaluated edge-of-field N and P losses resulting from the conversion to various hybrid poultry litter and supplemental inorganic N fertilization strategies. Results after 3 yr indicated that proper management, most importantly avoiding excess litter application, prevented excess nutrient loss and limited soil P buildup compared with the traditional practice of inorganic fertilizer application. Based on these initial findings, the authors concluded that annual litter application at 1 to 2 tons/acre (**ac**) supplemented with inorganic N would produce little or no negative water quality effect and at worst a slow increase in soil P concentrations. More than 4 yr of additional data have confirmed these initial findings (unpublished data) that low-rate litter fertilization can provide environmentally sustainable resource utilization. The question that remains, however, is whether a 1 to 2 tons/ac litter rate supplemented with recommended rates of inorganic N is economically feasible for off-site cultivated crop production. This question is vital, because in order for fertilizer alternatives to be widely adopted, they must be cost-effective.

The objective of this research was to determine the on-farm agro-economic effects of applying various combinations of poultry litter and commercial (inorganic) N fertilizer. The present study, which expanded the initial environmental analyses of Harmel et al. [14], evaluated the relationships between on-farm economic throughput (defined in this study as crop sales revenue minus fertilizer costs), production cost, litter application rate, and crop yield by varying 2 crop production inputs, poultry litter and commercial fertilizer.

MATERIALS AND METHODS

Six years of water quality, soil nutrient, and economic throughput data from 6 field-scale (10- to 21-ac) sites at the USDA-Agricultural Research Service Grassland, Soil and Water Research Laboratory near Riesel, Texas (Figure 1), were used in this study. Applied agronomic and hydrologic research has been conducted at this site since 1937, with the most recent emphasis on agricultural conservation practice effectiveness, specifically litter application management [15]. The present research is part of the national USDA Conservation Effects Assessment Project [16].

Each of the experimental units in this study was a field-scale small watershed with broad-base terraces on the contour and a grassed waterway. Soils on these sites are dominated by Houston Black clays (fine, smectitic, thermic, Udic Haplusterts), which are classic vertisols

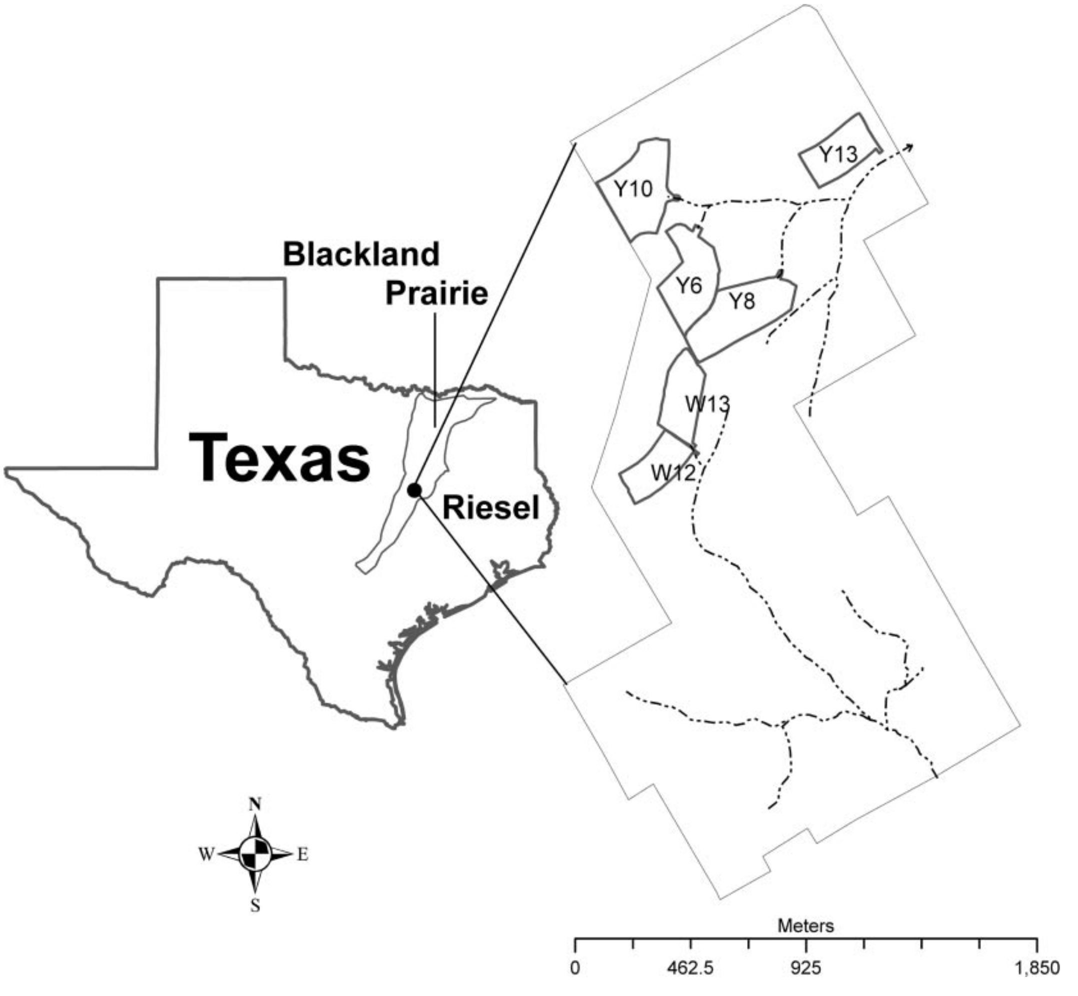

Figure 1. Cultivated study fields at the USDA-Agricultural Research Service Grassland, Soil and Water Research Laboratory, Riesel, Texas.

and thus shrink and swell considerably with changes in moisture content. Management was consistent between sites to minimize confounding differences; only the fertilization strategy (treatment) varied.

In 2001, each of these sites was left fallow with no application of fertilizer and no crop production to establish baseline conditions and ensure no inherent differences existed between sites. Soil and water quality data collected in the fallow year indicated no substantial differences [14]; thus, differences could be confidently attributed to treatment effects. The treatments, which were target annual litter application rates (0, 2, 3, 4, 5, and 6 tons/ac), were determined a priori and then randomly assigned to each of the 6 sites. The range of litter rates was chosen to encompass and exceed the range of realistic application rates utilized on off-site (third party) application fields. Although in hindsight, a 1 ton/ac treatment should also have been established.

At the time of application, litter samples were collected for analysis of moisture, C, N, and P. The litter was obtained from the cleanout (either complete cleanout for multiple flocks or “cake out” from a single flock) of turkey houses within the vicinity of the study site. The bedding material in litter was either wood shavings or rice hulls. The variable source and composition of the litter introduced considerable variability in moisture, N, and P content but not in C concentrations (Table 1).

From 2002 to 2007, a 3-yr cultivated crop rotation (corn-corn-wheat) was established, but each site received a different rate of inorganic fertilizer or poultry litter, or both. Site Y6 was randomly selected as the control watershed and thus received only commercial (inorganic) N and P. The other sites received between 2 to 6 tons/ac of poultry litter and varying rates of inorganic N fertilizer to meet the crop N requirements. In the corn years, crop N needs were set at 145 to 160 lb/ac based on recommendations by Gass [17]. In wheat years, only the control site Y6 received commercial N, because litter supplied adequate N for wheat production on the other sites.

Data Collection

Throughout the study, detailed management records including date and activity details were kept for each site. Each tillage, planting, harvest, pest control, and weed control operation was recorded, but the cost of these operations was not tabulated, because they did not vary across treatments. Other agronomic and economic data—specifically crop yields, crop prices, and purchase costs, application rates, and application costs for both litter and inorganic fertilizer—were also collected and utilized for economic analysis. Additional data on rainfall, runoff, water quality, and soil quality were also collected; however, discussion of these data are outside the scope of this manuscript. Initial data from the first 3 yr of the project were presented by Harmel et al. [14].

On-Farm Economic Throughput Analysis

On-farm economic throughput was determined based on revenue and cost data. In the present study, total revenue was a function of grain price as determined by market factors and grain yield as affected by numerous factors including climate, rainfall, soil conditions, and nutrient availability. Total variable costs were based only on fertilizer costs. Other costs including tillage, planting, harvest, and transportation costs were not included because they were consistent across treatments. Thus, throughput was defined as total revenue generated by crop sales minus fertilizer costs as determined by equation [1]:

$$TP = (GP \times YD) - [(LC \times LT) + (NQ \times CC + AC)], \quad [1]$$

where TP = throughput ($/ac); GP = grain price [$/bushel (**bu**)]; YD = grain yield (bu/ac); LC = litter cost ($/ton) including application cost; LT = litter rate (ton/ac); NQ = commercial (inorganic) N rate (lb/ac); CC = commercial (inorganic) N cost ($/lb); and AC = commercial application cost ($/ac).

Comparison of Results with Alternative Economic Analyses

To enhance the economic throughput analysis, profitability of the treatments was also compared with total budget analysis and long-term agro-economic simulation. Total budget analysis was performed for each treatment by subtracting the operating costs (including fertilizer costs as well as fuel, interest, and harvesting costs) from the gross crop sales (total revenue) as described by Harman et al. [18]. The WinEPIC model [19] was also used to simulate 45 yr of crop yields and profitability based on measured weather

Table 1. Litter properties presented on an as-is basis (not dry-weight basis) as means with SD in parentheses

						Water-extractable nutrients		
Year	n	Moisture (%)	Organic C (%)	Total N (%)	Total P (%)	NO_3-N (mg/kg)	NH_4-N (mg/kg)	PO_4-P (mg/kg)
2002	4	49.5 (15.4)	28.4 (6.3)	2.32 (0.33)	2.14 (0.12)	211 (245)	1,170 (370)	895 (238)
2003	4	9.8 (2.6)	31.2 (0.6)	3.05 (0.24)	3.47 (0.47)	857 (293)	3,775 (8)	1,233 (35)
2004	6	32.1 (4.0)	28.9 (0.3)	3.27 (0.14)	1.67 (0.23)	265 (240)	4,726 (1,160)	778 (258)
2005	4	28.0 (7.2)	28.4 (0.6)	2.27 (0.21)	1.99 (0.15)	510 (295)	2,917 (340)	799 (113)
2006	4	20.6 (4.0)	31.8 (0.7)	2.59 (0.25)	1.96 (0.16)	22 (24)	1,755 (92)	396 (23)
2007	5	14.8 (0.4)	32.3 (2.3)	2.72 (0.12)	1.41 (0.24)	7 (7)	2,870 (528)	2,953 (771)

data from the site (1962 to 2006). Seven litter and inorganic fertilizer rate combinations within 15 three-year corn-corn-wheat rotations were simulated [20]. First, profitability was estimated based on actual operating costs. Then, a sensitivity analysis and profit comparison for 5 litter cost scenarios ($20 to 30/ton) and 5 inorganic fertilizer cost scenarios ($450 to 850/ton) was conducted to evaluate the effects of increasing fertilizer costs.

Data Analysis

In this study, the 6 cultivated fields were the experimental units and the treatments were annual litter application rates of 0, 2, 3, 4, 5, and 6 tons/ac. The major null hypothesis evaluated was that there are no differences in average economic throughput between the fields with 6 different fertilizer strategies (equation [2])

$$H_0: \mu_0 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 \qquad [2]$$

where μ_0 = mean annual economic throughput for the control site and $\mu_{2,3,4,5,6}$ = mean annual economic throughput for the litter application sites at rates from 2 to 6 tons/ac.

The effect of litter application rate on economic throughput, crop yields, and fertilizer costs was evaluated with regression and 1-way ANOVA analyses. For all regression analyses, linear relationships were judged significant if the slope of the regression line was significantly different than zero based on an a priori $\alpha = 0.05$ probability level. Possible differences in mean values were analyzed with 1-way ANVOA followed by Tukey's mean separation test with a family error rate of 5%. All statistical tests were conducted with Minitab software [21] and procedures described previously [22, 23].

RESULTS AND DISCUSSSION

Crop Yield

During the 6-yr study period, corn yields averaged 102 bu/ac and wheat yields averaged 39 bu/ac. Compared with average yields in the 1990s on the same sites, these yields represented increases of 32% for corn and 22% for wheat. Annual precipitation totals ranged from 36.2 to 57.8 in., each of which exceeded the long-term (1939 to 1999) mean of 35.4 in [24]. Thus, annual rainfall was typically sufficient for crop growth, although short-term drought conditions did occur, resulting in temporary suboptimal production conditions.

Utilization of different litter and inorganic fertilizer combinations resulted in minimal effect on corn yields (Table 2). The only significant linear relationship between litter rate and annual corn yield occurred in 2005. The lack of consistent yield effects was expected, because available N was equivalent for all treatments in corn years and applied at rates not to limit crop production. Similarly, adequate P was applied to all treatments as to not limit production. The fertilization strategies also produced no significant differences in mean corn yields between treatments.

For wheat years, litter rate was not significantly related to yields, although available N applied was different between sites (Table 2). Also, no significant differences in mean wheat yields occurred between treatments. It should be emphasized that N application in excess of recommended rates based on appropriate yield goals did not increase yields and thus represented an unnecessary and unprofitable expenditure.

Variable Costs (Fertilizer Inputs)

In addition to crop yields, variable costs directly affected the on-farm economics of litter utilization. The variable costs in this study were the purchase and application costs for commercial fertilizer and poultry litter. The cost of commercial fertilizer for sites that received a combination of litter and inorganic N (Y8, W13, W12, Y10, and Y13) is presented in Table 3. Commercial N costs for site Y6, which served as the control and received no litter, are presented in Table 4. For the control site, the commercial fertilizer costs were slightly different than for the litter sites, because it received different formulations to provide N as well as P. Litter costs per ton, which included transportation to the sites and application, ranged from a low of $16.50 in 2002 to a high of $23.25 in 2007 (Table 3). This increase of 41% was much smaller than the 105 to 135% increase in commercial (inorganic) fertilizer costs in the same period. As a result of the substantial increases in inorganic fertil-

Table 2. Fertilizer application and crop yield and price data for the cultivated sites

Site	Target litter rate (tons/acre)	Litter N rate (lb/acre)	Inorganic N rate (lb/acre)	Total available N (lb/acre)	Crop yield (bushel/acre)
2002 corn ($2.54/bushel)					
Y8	6	125	20	145	115
W13	5	91	54	145	131
W12	4	71	74	145	114
Y10	3	61	84	145	129
Y13	2	39	106	145	134
Y6	0	0	145	145	107
2003 corn[1] ($2.15/bushel)					
Y8	6	139	19	158	103
W13	5	117	41	158	102
W12	4	95	61	156	105
Y10	3	81	75	156	108
Y13	2	50	106	156	100
Y6	0	0	155	155	100
2004 wheat[2] ($3.30/bushel)					
Y8	6	210	0	210	35
W13	5	153	0	153	35
W12	4	105	0	105	42
Y10	3	107	0	107	40
Y13	2	75	0	75	39
Y6	0	0	60	60	25
2005 corn ($2.00/bushel)					
Y8	6	162	0	162	95
W13	5	126	31	157	98
W12	4	83	72	155	95
Y10	3	80	77	157	92
Y13	2	56	100	156	87
Y6	0	0	155	155	77
2006 corn ($2.25/bushel)					
Y8	6	156	0	156	93
W13	5	131	24	155	84
W12	4	86	69	155	87
Y10	3	81	75	156	101
Y13	2	56	99	155	99
Y6	0	0	155	155	85
2007 wheat[2] ($5.00/bushel)					
Y8	6	164	0	164	42
W13	5	140	0	140	40
W12	4	111	0	111	45
Y10	3	86	0	86	43
Y13	2	60	0	60	42
Y6	0	0	84	84	44

[1]The 2003 corn yields were adjusted for uneven stands due to wet planting conditions.

[2]The 2004 and 2007 wheat yields were estimated by hand-clipping field plots due to wet harvest conditions.

izer prices and possible government subsidies to encourage off-site litter utilization (e.g., [25]), litter in certain regions may soon become an income source instead of a waste disposal cost to the poultry industry.

The total fertilizer costs did exhibit significant linear increases based on litter rate in each year of the study. Based on 1-way ANOVA and Tukey's test, the average per-ac fertilizer cost for the control site ($56), which received only inorganic fertilizer, was not significantly different than for the 2 tons/ac ($63) and 3 tons/ac ($77) litter rates. The fertilizer costs for the control site were, however, significantly less than for the 4 tons/ac ($95), 5 tons/ac ($108), and 6 tons/ac ($120) litter rate sites. Thus, the tradi-

Table 3. Commercial (inorganic) fertilizer and poultry litter costs for sites receiving both organic and inorganic fertilizer

Item	Inorganic fertilizer cost ($/ton)	N content (%)	Inorganic fertilizer cost ($/lb of N)	Commercial application cost ($/acre)	Litter cost applied ($/ton)
Year					
2002	125	32	0.20	4.00	16.50
2003	150	32	0.20	5.00	16.50
2004	—	—	—	—	18.00
2005	235	32	0.37	4.25	20.50
2006	375	46	0.41	5.00	22.50
2007	—	—	—	—	23.25
2002–2007 increase in inorganic N cost					105%
2002–2007 increase in litter cost					41%

tional practice of commercial (inorganic) fertilization and low rate litter application with supplemental N were clearly lower cost fertilization strategies during the study period. However, if commercial inorganic fertilizer costs continue to increase much more rapidly than litter costs, the economically optimal mix of inorganic and organic fertilizers may well shift toward relatively more organic (litter) fertilizer. Depending on the extent of the possible shift, litter fertilizer rates would have to be constrained at the 1 to 3 tons/ac range to minimize environmental concerns and encourage sustainable litter application.

Economic Throughput

For organic sources to be incorporated into fertilization schemes, they must be cost-effective in both the short- and long-term [12, 26]. On-farm economic throughput was used to make this determination for the present study. Annual throughput values were variable as shown in Table 5 and Figure 2. The greatest throughput values were obtained in 2002 due to the combination of relatively high corn prices (Table 5) and low fertilizer costs (Tables 3 and 4). The lowest throughput values were observed in 2004 when wheat prices were lowest (Table 5) and fertilizer costs were relatively high (Table 4).

In spite of the interannual throughput variability, the same 3 fertilizer treatments (commercial fertilizer only, 2 tons/ac litter with supplemental N, and 3 tons/ac litter with supplemental N) were the most profitable (based on economic throughput) in each of the study years. In 4 of the 6 study years, throughput for both the 2 and 3 tons/ac litter treatments exceeded throughput from the commercial fertilizer-only treatment, which is the typical practice.

In 2003 and 2007, significant linear relationships were observed between economic throughput and litter rate; as litter rate increased, throughput decreased. However, to better examine the effects of grain yield, grain prices, and fertilizer costs, average revenue and fertilizer costs were plotted with throughput (Figure 3).

Table 4. Commercial (inorganic) fertilizer costs for the control site that received only inorganic fertilizer

Item	Inorganic fertilizer cost ($/ton)	N content (%)	Inorganic fertilizer cost ($/lb of N)	Commercial application cost ($/acre)	Litter cost applied ($/ton)
Year					
2002	125	32	0.20	4.00	—
2003	184	25	0.37	5.00	—
2004	208	20	0.52	4.00	—
2005	215	25	0.43	4.25	—
2006	350	32	0.55	5.00	—
2007	330	35	0.47	4.00	—
2002–2007 increase in inorganic N cost					135%

Table 5. Annual total revenue, total fertilizer cost, and throughput

Site	Target litter rate (tons/acre)	Total revenue ($/acre)	Total fertilizer cost ($/acre)	Throughput ($/acre)
2002 corn ($2.54/bushel)				
Y8	6	291	107	184
W13	5	332	97	235
W12	4	290	84	206
Y10	3	335	70	265
Y13	2	341	58	283
Y6	0	272	32	240
2003 corn ($2.15/bushel)				
Y8	6	222	108	114
W13	5	219	97	122
W12	4	226	85	141
Y10	3	232	72	160
Y13	2	215	63	152
Y6	0	214	62	152
2004 wheat ($3.30/bushel)				
Y8	6	117	108	9
W13	5	114	90	24
W12	4	137	72	65
Y10	3	132	54	78
Y13	2	129	36	93
Y6	0	81	35	46
2005 corn ($2.00/bushel)				
Y8	6	191	123	68
W13	5	195	118	77
W12	4	191	113	78
Y10	3	184	94	90
Y13	2	174	82	92
Y6	0	153	71	82
2006 corn ($2.25/bushel)				
Y8	6	209	135	74
W13	5	190	127	63
W12	4	195	123	72
Y10	3	227	103	124
Y13	2	224	90	133
Y6	0	190	90	100
2007 wheat ($5.00/bushel)				
Y8	6	212	140	72
W13	5	201	116	85
W12	4	226	93	133
Y10	3	215	70	145
Y13	2	209	47	162
Y6	0	220	44	176

At the 0 tons/ac litter rate (inorganic fertilizer only), fertilizer costs were minimized but so was revenue; therefore, throughput was moderate. As litter rate increased (and the proportion of commercial N decreased), fertilizer costs increased and revenue increased up to the 3 tons/ac rate then decreased and remained steady at the 4, 5, and 6 tons/ac rate. Average throughput increased from 0 tons/ac (inorganic fertilizer only) to 2 tons/ac but then decreased as fertilizer costs increased. Although there was no significant difference in average annual throughput values due to considerable interannual throughput variability, the trend in average throughput is clear (Figure 2). This relationship between litter rate and annual average throughput is well represented (r = 0.995) by a quadratic polynomial relationship.

Based on this relationship, the greatest average annual throughput values ($153 to 154/ac) occurred for the 1 and 2 tons/ac litter treatments with the throughput maximum ($155/ac) occurring at about 1.5 tons/ac. The commercial fertilizer-only treatment and the 3 tons/ac litter treatment also produced relatively high throughput values ($133 to 144/ac), but these values were 7 to 14% less than the throughput maximum. At litter rates greater than 3 tons/ac, throughput values declined rapidly due to the combination of greater litter costs and the lack of significant production responses to the increased litter rates. In essence, diminishing returns were observed as the greater litter rates increased costs with no compensating greater yields to provide offsetting revenues.

Profitability results based on economic throughput analysis were confirmed with total budget analysis and long-term agro-economic simulation. Total budget analysis indicated that the greatest annual average profit occurred for the 2 tons/ac ($56/ac) and 3 tons/ac ($55/ac) litter rates [18]. Annual profit for the inorganic fertilizer treatment averaged $41/ac and was less than $25/ac for the 4, 5, and 6 tons/ac treatments.

Based on long-term WinEPIC simulations, profitability occurred in the following order: 1 ton/ac >2 tons/ac >0 tons/ac (inorganic only) > 3 tons/ac [20]. At rates greater than 3 tons/ac, profits decreased further. These results, which also confirm that maximum profit levels occur at the 1 to 2 tons/ac annual litter rate, were consistent under baseline economic conditions, under litter cost scenarios from $20 to 30/ton, and under inorganic fertilizer cost scenarios from $450 to 850/ton. These results for greater litter and inorganic fertilizer cost scenarios are especially important given the recent increases in fuel and fertilizer costs and the uncertainty of future economic conditions.

One important aspect of this research is that the economically optimal litter rate (1 to 2 tons/ac) is also environmentally optimal in terms of minimizing nutrient runoff, preventing rapid buildup of soil P and micronutrients, and providing a sustainable fertilizer alternative [14]. It

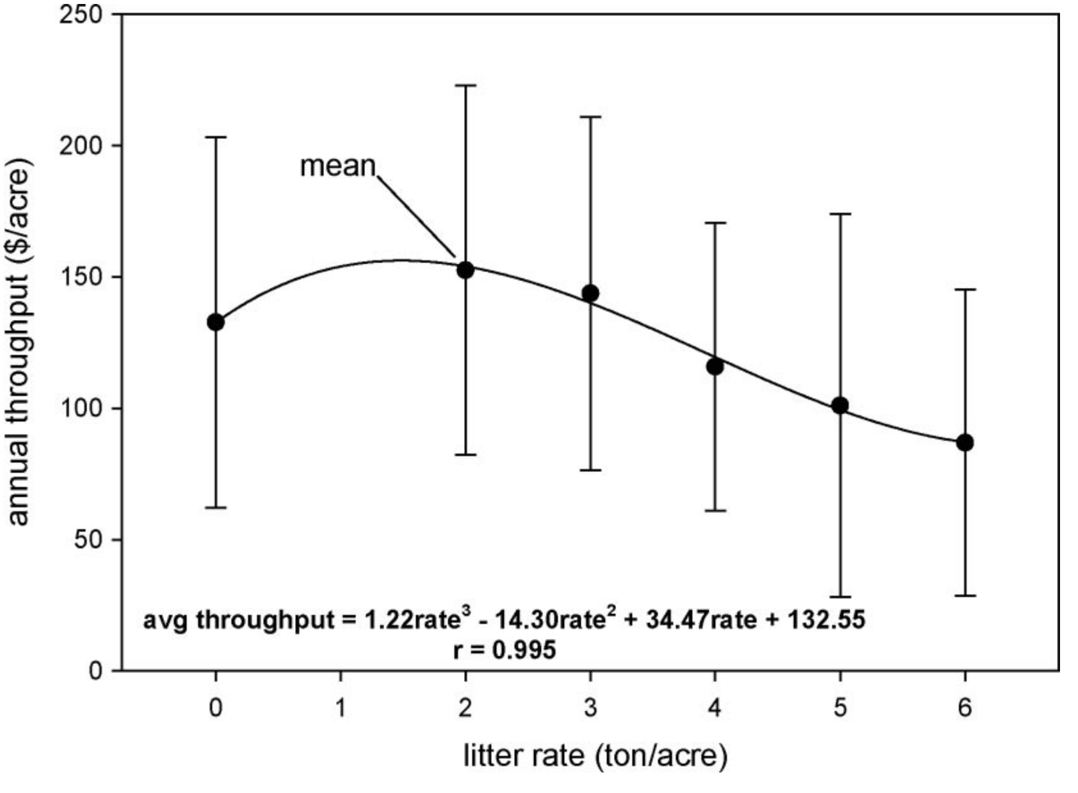

Figure 2. Annual throughput values presented as the treatment mean (±1 SD) for the 6 fertilizer treatments. avg = average.

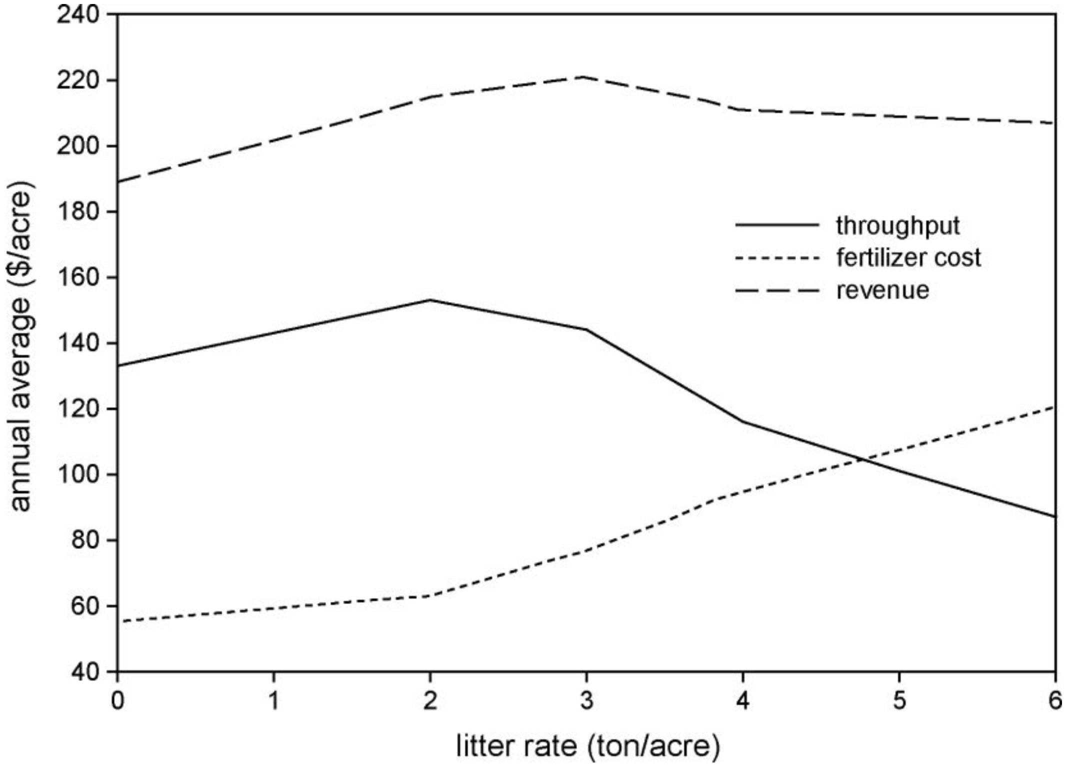

Figure 3. Annual average total revenue, total fertilizer cost, and throughput.

is hoped that this result will provide the scientific basis for a cost-effective, environmentally friendly fertilizer alternative (1 to 2 tons/ac of poultry litter with appropriate supplemental N) for cultivated crop production in this and similar regions. It should be kept in mind, however, that the environmental and economic effects of litter application might be different in areas with differing soil types or cropping systems.

In regions with concentrations of surplus litter, the present results support a win-win scenario for environmentally friendly litter utilization. Although litter disposal and environmental considerations represented financial costs in the past, providing a cost-effective fertilizer alternative could generate a revenue source for poultry producers rather than a cost. Similarly, the availability of cost-effective organic fertilizer would benefit local farmers and ranchers, who are faced with increasing fertilizer costs. This win-win scenario also facilitates a proactive, industry-led litter management program that prevents environmental problems instead of waiting to fix them when or if they occur. Such a proactive approach would benefit taxpayers by decreasing remediation and water treatment costs, benefit the poultry industry by avoiding environmental litigation and enhancing public perception, and benefit farmers and ranchers by providing a profitable fertilizer alternative.

CONCLUSIONS AND APPLICATIONS

1. An annual fertilization strategy with 1 to 2 tons/ac of poultry (turkey) litter and recommended supplemental N maximizes on-farm profitability for cultivated crop production off-site of poultry production facilities. Treatments with commercial (inorganic) fertilizer only and 3 tons/ac litter with supplemental N also produced relatively high profits, but greater litter rates rapidly decreased profits.
2. The economically optimal range of litter rates coincides with the environmentally optimal rate in terms of minimizing nutrient runoff, preventing rapid buildup of soil P and micronutrients, and providing a sustainable fertilizer alternative.

3. In regions with concentrations of surplus litter, the present results support a win-win scenario for environmentally friendly litter utilization. In this scenario, farmers and ranchers gain a cost-effective fertilizer alternative, the public saves remediation and water treatment costs, and the poultry industry enhances its public perception, avoids litigation, and increases its revenue potential.

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Acknowledgments

Through various funding mechanisms, including its Total Maximum Daily Load (TMDL) program and §319 Nonpoint Source grant program in cooperation with the US Environmental Protection Agency, the Texas State Soil and Water Conservation Board (TSSWCB) has supported this research since 2001. The vision, dedication, and appreciation of the TSSWCB for real-world, long-term research and problem solving deserves special recognition.