



## A COMPARATIVE ECONOMIC ANALYSIS OF BROILER LITTER USAGE ALTERNATIVES AS A SOURCE OF FERTILIZER AND A SOURCE OF ENERGY PRODUCTION IN JORDAN

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**Table 1.** Development of broiler farm and its capacity in Jordan (1984-2014)

### ABSTRACT

The increase of broilers production in Jordan makes it urgent to study broiler tiller produced. So, the study uses the economics of broiler litter concerning its usage as a source of energy production or as a source of fertilizers. The reuse of broiler litter (BL) will reduce the environmental impact. This empirical term paper used the different alternatives to manage broiler tiller. Many assumptions have been made to reach the feasibility of managing broiler litter. The results showed that the cash flow of using litter as a source of fertilizer was higher compared to use it for energy production for the years of study (1992-2014). The use of litter as a source of fertilizer as a source of fertilizer is more feasible than being used as a source of energy. The study recommended that the collected litter of broiler farms should be treated through specialized party to increase the economic feasibility and minimize the environmental effects.

### INTRODUCTION

Broilers production in Jordan is considered one of the important industries (**Al-Sharafat and Al-fawwaz, 2013**). The development of this industry started since 1960. This industry developed through the previous four decades to reach a position satisfaction Jordan consumption needs of broiler chicken. The number of producing farms increased from 1233 farms in 1984 to 2,170 farms in 2014. On the hand the number of broiler chicken increased from 10,670 birds in 1984 to 171230 thousand birds in 2014 (**Table 1**). This increase of the number of farms presents a new challenge of efficient and environmentally sound management

Year	Number of Farms	Total Capacity (Thousand birds)
1984	1233	10670
1985	1326	11748
1986	1401	12403
1987	1469	12700
1988	1360	12253
1989	1389	11460
1990	1448	13600
1991	1570	16668
1992	2210	17900
1993	2114	18500
1994	2138	21042
1995	2125	21415
1996	2156	22337
1997	2205	23746
1998	2288	22410
1999	2149	24290
2000	2074	23880
2001	2140	24210
2002	2213	29181
2003	2206	29140
2004	2164	26040
2005	2202	27530
2006	2120	45383
2007	2168	63627
2008	2297	81176
2009	2135	84920
2010	2170	106524
2011	1866	112000
2012	1722	168000
2013	2115	167000
2014	2170	171230

Source: Department of Statistics, (1992-2015). The annual report of Animal Fortune Department, Amman, Jordan

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of broiler litter (BL) in Jordan. Improper management of BL would increase the levels of phosphorous in soil. The addition of BL with high quantities would lead to pollution of soil through the accumulation of P and N (Sturgeon, 2008).

An alternative solution for BL may be to use it as a fuel source for power generation. The technologies regarding the use of biomass to produce energy were introduced by many researchers (Hamad et al 2014 and Diji, 2013). However, efficient combustion of animal waste has had limited success because of its higher ash and moisture contents and other product inconsistencies as compared to coal and natural gas.

This term paper objective is to analyze economic feasibility of broiler litter and decide which method of either disposing the broiler litter or to use it as soil fertilizer will be more feasible.

## MATERIAL AND METHODS

This term paper will use the last five years concerning the number of farms and the number of birds to find out the economic analysis, which determine the more feasible method to practice with the broiler litter; using it as a source of fertilizer or as a source of energy production. To conduct the economic analysis it was assumed that a well-managed, 2,213-bird poultry house can annually produce 5.5 flocks of birds weighing 4.5 pounds with 94.5% usable birds that dress 75%. This is equivalent to 414,176 lbs of marketable whole-bird poultry per year (Doye et al., 1992). According to the previous method of finding out the amount of litter will be produced, the following table illustrates, the development in litter production cost and return in Jordan considering (Table 2) using the following assumptions:

1. The cost of transporting 1 ton litter is JD0.5 as a fertilizer.
2. The price of sold litter as a source of fertilizer is JD1.5/ton.
3. The cost of transporting is JD 0.25/ton in case of being used as a source of energy.
4. The price of sold litter as a source of energy is JD 0.75/ton.
5. The amount of litter produced is about 0.005 ton/bird per flock.

To calculate the Net Present Value (NPV), the cost of litter transportation as fertilizer and source of energy were calculated, and the revenues from litter selling as a source of fertilizer and source of

energy were also calculated. The NPV was calculated using the following equation:

$$NPV = \sum R_i / (1+i)^t$$

Where;

t=time

i = discount rate

R<sub>i</sub> = net cash flow.

## Previous studies of Using Broiler Litter

### 1- Broiler Litter as Fertilizer in Livestock Operations

Major competitors of fresh-meat market are poultry and beef. On the other hand, farming of poultry and beef is directly related to environmental impact as well as economic viability (Maguire et al 2008).

The high distribution of poultry farms increases the production of litter over years. The expansion of this industry to meet the consumption rates will contribute to environmental problems if not dealt with properly (Diji, 2013). The increase of litter production directed behavior to utilize it in other activities that are feasible. One of major alternatives to dispose litter is to use it as a source of fertilizer or energy production.

The extent of litter production from poultry farms in USA makes it urgent for the farmers to think seriously and have plans to deal with tons of litter produced annually. In USA, states regulations should be followed by farmers to dispose tons of litter to avoid environment infections (Schnitzer et al 2008).

### 2- Environmental and Economic Precautions

Broiler litter is a poultry industry by-product that must be disposed of in an environmentally sound and economically efficient manner. The use of broiler litter as both a fertilizer source for permanent grass pastures or as preplant, soil-incorporated fertilizer for cool-season annual pastures and as a feed source for beef cattle is environmentally sound and economically efficient if proper precautions are taken. Broiler litter should be generated on the producer's own farm or purchased only from a licensed, reputable dealer to ensure that the quality of the broiler litter is suitable for its intended purpose. When broiler litter is used as a fertilizer, soils should be sampled and analyzed annually to prevent deficiencies or excesses of nutrients.

**Table 2.** The production of litter, cost and net returns of using broiler litter as fertilizer and as a source of energy during the period 1992-2014

Year	No. of birds (thousand birds)	Annual litter produced (Thousand tons)	Cost per ton as a fertilizer (Thousand JDs)	Cash in as a fertilizer (Thousand JDs)	Cost per ton as a source of energy (Thousand JDs)	Cash in as a source of energy (Thousand JDs)
1992	2210	89.50	44.75	134.25	22.38	67.13
1993	2114	92.50	46.25	138.75	23.13	69.38
1994	2138	105.21	52.61	157.82	26.30	78.91
1995	2125	107.08	53.54	160.61	26.77	80.31
1996	2156	111.69	55.84	167.53	27.92	83.76
1997	2205	118.73	59.37	178.10	29.68	89.05
1998	2288	112.05	56.03	168.08	28.01	84.04
1999	2149	121.45	60.73	182.18	30.36	91.09
2000	2074	119.40	59.70	179.10	29.85	89.55
2001	2140	121.05	60.53	181.58	30.26	90.79
2002	2213	145.91	72.95	218.86	36.48	109.43
2003	2206	145.70	72.85	218.55	36.43	109.28
2004	2164	130.20	65.10	195.30	32.55	97.65
2005	2202	137.65	68.83	206.48	34.41	103.24
2006	2120	226.92	113.46	340.37	56.73	170.19
2007	2168	318.14	159.07	477.20	79.53	238.60
2008	2297	405.88	202.94	608.82	101.47	304.41
2009	2135	424.60	212.30	636.90	106.15	318.45
2010	2170	532.62	266.31	798.93	133.16	399.47
2011	1866	560.00	280.00	840.00	140.00	420.00
2012	1722	840.00	420.00	1260.00	210.00	630.00
2013	2115	835.00	417.50	1252.50	208.75	626.25
2014	2170	856.15	428.08	1284.23	214.04	642.11

Source: Department of Statistics, 1992-2015. Animal Production Report. Amman, Jordan.

### 3- Broiler Litter as A source of Energy

An alternative solution to applying BL on land may be to use it as a fuel source for power generation. Researchers have summarized various technologies that use feedlot (beef cattle) biomass as a fuel energy source (**Annamalai et al 1987 and Sweeten et al 1986**). However, efficient combustion of animal waste has had limited success because of its higher ash and moisture contents and other product inconsistencies as compared to coal and natural gas.

The following represents a comparison with coal as a source of energy: Broiler Litter (BL) is a lower quality fuel than coal due to its high nitrogen, high sulfur, high moisture, high ash, and low heating value.

- BL has greater volatile matter on a dry ash free basis as compared to coal. This may aid in enhancing combustion
- All BL fuels have similar properties on a dry ash free basis except for nitrogen which is higher in EM than in CL.
- Litter based fuels are higher in volatile oxides, which leads to higher rates of fouling.

- Use of litter with coal in a 90:10 blend results in similar fuel costs as compared to coal, and reduction in the fouling potential as compared to pure litter.

Based on these findings, further testing of BL fuels in a small-scale boiler burner is necessary to assess fouling and corrosion potential along with combustion efficiencies of these fuels.

## RESULTS

Using above- mentioned assumption in the methodology, the net present value using 0.08 discount rate of the two alternatives was calculated (**Table 3**). The results showed that the NPV of using broiler litter as a source of fertilizer is considered more feasible more than using broiler tiller as a source of energy production. The net present value of the first alternative was 513 thousand JDs, while, on the other hand, the net present value of using broiler tiller as a source of energy was 257 thousand JDs. This indicates that the use of broiler litter as a source of fertilizer will be more feasible.

**Table 3.** The calculation of the net present value (NPV) of the two methods of using litter

Year	As Fertilizer Source			As Energy Source		
	Cash In	Cash Out	Net	Cash In	Cash Out	Net
1992	134.25	44.75	89.50	67.13	22.38	44.75
1993	138.75	46.25	92.50	69.38	23.13	46.25
1994	157.82	52.61	105.21	78.91	26.30	52.61
1995	160.61	53.54	107.08	80.31	26.77	53.54
1996	167.53	55.84	111.69	83.76	27.92	55.84
1997	178.10	59.37	118.73	89.05	29.68	59.37
1998	168.08	56.03	112.05	84.04	28.01	56.03
1999	182.18	60.73	121.45	91.09	30.36	60.73
2000	179.10	59.70	119.40	89.55	29.85	59.70
2001	181.58	60.53	121.05	90.79	30.26	60.53
2002	218.86	72.95	145.91	109.43	36.48	72.95
2003	218.55	72.85	145.70	109.28	36.43	72.85
2004	195.30	65.10	130.20	97.65	32.55	65.10
2005	206.48	68.83	137.65	103.24	34.41	68.83
2006	340.37	113.46	226.92	170.19	56.73	113.46
2007	477.20	159.07	318.14	238.60	79.53	159.07
2008	608.82	202.94	405.88	304.41	101.47	202.94
2009	636.90	212.30	424.60	318.45	106.15	212.30
2010	798.93	266.31	532.62	399.47	133.16	266.31
2011	840.00	280.00	560.00	420.00	140.00	280.00
2012	1260.00	420.00	840.00	630.00	210.00	420.00
2013	1252.50	417.50	835.00	626.25	208.75	417.50
2014	1284.23	428.08	856.15	642.11	214.04	428.08
NPV			2027.4			1013.71

Source: Calculated by researcher

Economic analysis result indicated the usage of broiler litter as a source of fertilizer but many points should be considered when dealing with broiler litter as a fertilizer. One main point that should be considered is the deep penetration of macro elements to the ground water which causes the pollution of ground water. The other point to be considered is the environmental impact of litter decomposition. These considerations should be studied before the usage of broiler litter as a source of fertilizer. On the other hand, the usage of broiler litter as a source of energy will have less impact on environment as the litter will be replaced in special well prepared equipment to be treated to produce energy.

#### CONCLUSION

According to the previous results, the following conclusions could be stated

1. The usage of boiler tiller as a source of fertilizer is more feasible economically than using it as a source of energy.

2. The usage of broiler tiller as a source of energy will have less impact on the environment as compared with being used as a source of fertilizer, especially when developed equipment is used for the conversion process.

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