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Full Length Research Paper

Economics of medium-scale on-station broiler production

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This study was conducted at the broiler farm of the Biotechnology and Nuclear Agriculture Research Institute. Data on total fixed and variable costs for eight different phases of units produced were obtained and parameters of profitability associated with production economics were analysed using the production function. The results indicated that total broiler yield for all the production phases amounted to seven thousand, nine hundred and five (7,905) out the total number of eight thousand, three hundred and seventy-nine (8,379) day old chicks bought, indicating a cumulative mortality of 5.99%. Broiler yield was 95.0%, 95.4%, 96.7%, 70.6%, 95.2%, 99.2%, 97.2% and 95.4% for each of the eight different production phases. Analyses of the Average Physical Product (APP) and Average Value Product (AVP) indicated that production was done efficiently and that variable input used were readily converted into output for all the phases of production. Results indicated that feed outlay constituted the greatest limiting factor in broiler production at the BNARI farm. However, profitability(π) was good for all the different production phases as Total Value Product (TVP) was higher than Total Cost (TC) except at the sixth phase of production.

Keywords: *ad libitum*, day-old chicks, broiler yield, profitability, production function.

INTRODUCTION

The Food and Agriculture Organization (FAO) of the United Nations estimated that global poultry (broiler) production grew by 1.6% to 108.7million tonnes in 2014. The expansion was driven mainly by the developed countries as production in developing countries continued to decline (FAO, 2014). However, Africa's production represents just about 5% of the global production with South Africa (1.3 million tonnes) as the leading producer, followed by Egypt (633,000 tonnes), Morocco (502,000 tonnes), Algeria (251,000 tonnes), Nigeria (250,000 tonnes) and Ghana (30,000 tonnes) as reported in the 2010 edition of the poultry site. Broiler meat is now gaining substantial in rows into protein intake in many African countries (Daghir, 2008). Soniaya (1997) and Gueye (1998) reported that almost 80% of the poultry production in Africa is found in rural and peri-urban areas. Per capita broiler meat consumption has also increased significantly with increase in population in Africa, including Ghana where production has been rising steadily.

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The Ghana poultry (broiler) sector

The poultry industry in Ghana has gone through various challenges over the past three decades due to trade liberalisation policies, EU trade restrictions, incidence and severity of infectious diseases and climate change. Ghana is among the countries where imports are projected to increase most as income growth strengthens demand (FAO, 2014; Banson *et al.,* 2015).

Before the 1970s, broiler production mainly operated on the household level as there was very little marketable surplus beyond household consumption. During the 1970s, the broiler industry in Ghana experienced significant growth due to the then government policy of "Operation Feed Yourself", leading to an increase in domestic demand. During this period the poultry (broiler) industry in Ghana was heavily regulated. Poultry chicken production in Ghana became organized on a business basis from the early 70's and showed significant growth from 1975–1980 (Girdner *et al*., 1980).

The purpose of regulating the poultry industry in Ghana was to increase poultry production to meet the increasing local demand for chicken meat. All these regulations helped the broiler sector to achieve higher growth rates, but it seemed from the mid 80s the enforcement of the policy was relaxed and the broiler market was liberalized. The absence of direct support in terms of subsidy and import restrictions of the broiler industry in Ghana and the continued growth of the EU sector has brought Ghana's broiler enterprises under increased pressure. Broiler production involves the keeping of chickens of heavy meat breeds for the purpose of getting good quality meat products usually sold live or processed at ten to twelve weeks of age (Amos, 2006).

Chicken import into Ghana in 2012 was estimated at 73,788.4 metric tons with production lagging at 46,308 metric tons leaving a deficit of 27,480.4 metric tons (MOFA, 2012). Although production capacity and markets exist for the broiler industry in Ghana, little is done to motivate farmers and especially the teeming unemployed youths in the country to venture into the industry to increase food security and promote pro-poor growth. In order to close production gap, scientists of the Biotechnology and Nuclear Agriculture Research Institute (BNARI) established experimental poultry unit which has been running for two years now. The aim of this study is, therefore, to determine the level of profitability of broiler chicken production at the BNARI farm. Analyses of profitability of poultry and livestock productions have been developed by authors such as Brown, (1979; Crotty, (1980); Gittenger, (1982); and Simpson, (1988). This study however employed the farm level profitability models described by Boehlje and Eidman (1984) for the analyses of the data. Profitability analysis as an economic tool in assessing input-output relationship enables prudent resource allocation in order to maximize profit and/or minimize cost (Doll and Orazem, 1984). Therefore, for the production level decision maker like BNARI seeking to maximize profit, the determination of profitability is very useful in helping to allocate scarce resources. It is also important to determine the current profitability level of BNARI broiler production, since on the agricultural markets, prices of inputs are more volatile due ostensibly to production uncertainties and inelastic demand nature of most agricultural produce (Rezitis and Stavropoulos, 2010).

METHODOLOGY

The study was carried out at the BNARI farm which forms the commercialization unit of the institute. An initial number of 500 imported day-old chicks were raised for the first phase of production. Eight phases of production were undertaken on quarterly basis starting from April 2013 to December 2014, with a total of 8,379 broiler birds produced of which total mortality was 474, and the matured birds sold to the consuming public. BNARI adopted the deep litter system for broiler production. The biological material (broiler breeds) produced are the imported "Ross and Cobbs" breeds. The brooding period lasts for 14 weeks after which the birds are moved to the growth house. Microclimatic factors such as temperature and relative humidity values in both the brooder and growth houses were regulated in accordance with general best practices as reported by Banson *et al.,* (2015). The lightning schedule varies depending on the age of the birds. 24 hours of light were provided from day 1 to day 7; 23 hours of light from day 8 to day 35; with intermittent dark periods at night time and 24 hours of light from day 36 to day 42. Broiler production at the BNARI farm takes exactly 6 weeks (42 days) to mature, and are ready for sale as a result of the quality feed specially formulated to feed the birds.

Vaccination against chicken diseases such as Newcastle, Gumboro, Marek's disease, Coccidiosis are done by administering a Coccidiostats, and Water Soluble Powder (WSP) broad spectrum antibiotics. A BNARI formulated probiotics based feed diet mixed with the required amount of protein and energy are given to the birds. The main feed ingredients include maize (yellow) to provide carotene which cannot be synthesized by the birds, wheat bran, soyabean meal; vitamin-mineral premixes, shell grit, dicalcium, RE3, salt, methionine and lysine. Three different feed rations are therefore provided *ad libitum* depending on the age of the birds during the growth period; starter, grower and finisher. Water is also provided *ad libitum*. The unit cost of these items constitutes the total variable cost of production while the investment on brooder

house and permanent house structure make up the total fixed cost.

2.2 Determination of feed and broiler costs

Feed cost was computed based on the price per kilogram of the ingredients used in the feed formulation. The birds were priced based on the cost incurred for that phase of production. A 5% of the total fixed cost was always added to the total variable cost in the determination of the price per live bird in order to defray total fixed cost outlay. For production phase 1, price per bird was GH¢18.00. Price per bird for productions phases 2, 3, 4, 5, 6, 7 and 8 were GH¢20.00, GH¢22.00, GH¢25.00, GH¢26.00, GH¢27.00, GH¢28.00 and GH¢36.00, respectively.

Broiler production models for profitability analysis

Extrapolations from the general production function developed by Boehlje and Eidman, (1984) form the basis for the analysis of the data. The general production function is written as;

$$Y = f(X_1, X_2, X_3, \ldots X_{(n-1)}, X_n)$$

where Y= Total output in terms of total broiler produced per production, X= represents the four main combined variable inputs (purchase of Day Old Chicks (DOCs), feed, veterinary drugs and water).
Average Physical Product (APP), which indicates how efficiently input is converted into output, is estimated as,

$$(APP) = \frac{Y}{X} = f\left(\frac{X_1/X_2,\ldots X_n}{X}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Y is the total broiler output per production and X the set of combined variable inputs used per production.
The Total Value Product (TVP) is the total monetary value of all the different phases of a production. The TVP is also the total revenue generated from each stage of the broiler production. This is computed as follows:

$$TVP = P_Y * Y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

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The Average Value Product (AVP) which is the average physical product (APP) multiplied by the price per live bird is computed as follows:

$$AVP = APP * P_Y = \left(\frac{Y}{X}\right) * P_Y = \frac{TVP}{X} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where P_Y is the price per bird and Y the total broiler output.
Total variable costs (TVC) are the total monetary costs for variable input used for each production phase. These variable inputs were identified as feed, purchase of DOCs, drugs and water.

$$TVC = P_x * X \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where X= the amount of variable input used; and P_x = the price per unit of input.

Total fixed costs (TFC) are the total monetary value of fixed inputs used for production. These costs were also computed for each production phase.
Total Cost (TC) is the total monetary value of the all cost of production. This cost is quantified for the eight different phases of the productions as the summation of Total Variable Cost (TVC) and Total Fixed Cost (TFC).

$$TC = TVC + TFC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Profit (π) is computed as the $TVP - TC$. This is the net returns or net revenue obtained from the broiler production for each production phase. The profit is therefore computed as:

$$Profit(\pi) = TVP - TC = TVP - TVC - TFC$$

$$\pi = P_Y * Y - P_X * X - TFC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where π = profit or net returns or net revenue, X= amount of variable input used for production, P_X = the price per unit of equipment bought for the brooder and permanent houses.

RESULTS AND DISCUSSION

The total number of birds produced for each phase of production after mortalities have been accounted for, are displayed in **Table 1**. Out of the total number of eight thousand, three hundred and seventy-nine (8,379) day old chicks raised for all the phases of production, the total mortality was four hundred and seventy-four (474) representing 5.99% of the total number of matured birds produced. Total number of matured chickens sold was seven thousand, nine hundred and five (7,905).

Analysis of costs and total value product for the different production phases

Analysis of costs and revenue are displayed in Table 2. The total cost outlay on production phase 1 amounted to GH¢6,959.00. This total cost was made up both fixed and variable costs. The fixed cost include expenses on building of brooder and permanent houses and depreciation cost of the building and other fixed inputs such as wheel barrow, feeders, drinkers and knives. The variable cost was largely made up of feed, cost of day old chicks, expenses on veterinary drugs and purchase of water.

Table1: Broiler prod uction outlook for the 8 phases of production

Production stage	No. of DOCs	No. of matured birds	Mortality (%)
1	500	475	5.20
2	700	668	4.57
3	700	677	3.29
4	700	494	29.43
5	700	667	4.71
6	1,380	1,369	0.80
7	1,500	1,458	2.80
8	2,199	2,097	4.63
TOTAL	**8,379**	**7,905**	**5.99%**

Total value product obtained from production phase 1 amounted to GH¢8,550. For production phase 2, additional fixed cost incurred on building due to expansion works increased the total cost to GH¢11,193.18 with revenue also increasing to GH¢13,360.00 as shown in (Table 2) from the sale of 668 birds. From the results obtained it was evident that the total cost for production phases 3, 4 and 5 were GH¢8,853.60, GH¢8,941.60 and GH¢9,018.00, respectively with no significant differences in cost since number of birds raised for each level were the same, that is 700 birds. However, the total value product generated was lower for production phase 4 than for 3 and 5 due to a national outbreak of Gumboro disease which led to high rate of mortality as shown in Table 1.

Further fixed cost incurred on building for the production phase 6, as a result of expansion works, increased the total cost for that production phase to GH¢56,217.10 with total value product being GH¢36,963.00 from the sale of 1,369 birds. For production phase 7, the total cost expended was GH¢29,650.00, with total value product for that production phase increasing to GH¢40,824.00 from the sale of 1,458 birds as shown in Table 2.

The results also show that for the 8th production phase the total cost increased to GH¢54,542.00 as a result of increased number of birds from 1,458 from production 7 to 2,199. The total value product generated was GH¢75,492.00. The analyses also show that feed cost component of the variable cost was the greatest contributor to the costs of production for the various production phases. The aggregate total fixed cost amounted to GH¢37,276.78.

The aggregate total variable cost for all the production phases was GH¢148,447.70 with feed cost amounting to GH¢92,840.49, representing 62.54% of the production cost. This finding supports the views of Hertel *et al*., (2008); Taheripour *et al*., (2008); Tyner and Taheripour, (2007); Tokgoz *et al*., (2007) and Tyner (2007) who all identified feed cost as the single most important limiting factor in broiler production.

3.3 Analysis of broiler profitability

Rushton (2009) interpretated and discussed the profitability of diary production in terms of feed use and the associated value of output, costs, and profitability using the parameters in Table **3**. The input column represents the cost of the combined variable inputs used per number of broiler birds produced and the corresponding output obtained.

The results for the average physical product indicated that BNARI broiler production is done efficiently as inputs used for each production phase were converted into output and that there was no waste in variable input. The corresponding average value product also showed that productivity was enhanced during all the production phases. The results indicated that total value product (revenue) for each production level was higher relative to the total cost. But there was a marginal decline in TVP for the production phase 4 due to lower APP as a result of higher mortality of birds during production.

The analyses also revealed that TVP was lower for production level 6 as TC was higher. This also affected the profit for that phase which was negative. The higher TC came about as a result of additional expenditure on fixed cost during that phase of production. The analysis from the profitability results showed that broiler production was highly profitable as TVP was higher than TC for all the production phases except at the sixth phase of production. This notwithstanding, broiler production at the BNARI farm is still profitable since in the long run the higher expenditure on the total fixed cost for production 6 would be paid for as production continues.

Table 2: Cost and total value product analyses associated with broiler production.

Variable	Number	Unit cost/bird	Amount GH(¢)
Fixed Cost (Production phase 1)			
Brooder house equipment	-	-	800.00
Brooder and permanent structure	-	-	1,200.00
Depreciation cost of fixed inputs	-	-	500.00
Total Fixed Cost			2,500.00
Variable Cost			
Feed (starter, grower and finisher)	-	4.32	2,159.00
Purchase of DOCs	500	3.00	1,500.00
Veterinary drugs	-	1.20	600.00
Purchase of water	-	0.40	200.00
Total Variable Cost (TVC)			4,459.00
Total cost $TC = (TVC + TFC)$			6,959.00
$\boldsymbol{TVP}$	**475**		**8,550.00**
Fixed Cost (Production phase 2)			
Brooder and permanent structure	-	-	2,925.00
Depreciation cost of fixed inputs	-	-	450.00
Total Fixed Cost (TFC)			3,375.00
Variable Cost			
Feed (starter, grower and finisher)	-	5.92	4,144.00
Purchase of DOCs	700	2.30	1,610.00
Veterinary drugs	-	2.66	1,864.18
Purchase of water	-	0.29	200.00
Total Variable Cost (TVC)			7,818.18
Total cost $TC = (TVC + TFC)$			11,193.18
$\boldsymbol{TVP}$	**668**		**13,360.00**
Fixed Cost (Production phase 3)			
Depreciation cost of fixed inputs	-	-	400.00
Total Fixed Cost (TFC)			400.00
Variable cost			
Feed (starter, grower and finisher)	-	7.79	5,452.60
Purchase of DOCs	700	2.40	1,680.00
Veterinary drugs	-	1.74	1,121.00
Purchase of water	-	0.29	200.00
Total Variable Cost (TVC)			8,453.60
Total cost $TC = (TVC + TFC)$			8,853.60
$\boldsymbol{TVP}$	**677**		**14,894.00**
Fixed Cost (Production phase 4)			
Depreciation cost of fixed inputs		-	388.00
Total Fixed Cost (TFC)			388.00
Variable cost			
Feed (starter, grower and finisher)	-	7.79	5,452.60
Purchase of DOCs	700	2.40	1,680.00
Veterinary drugs	-	1.74	1,121.00
Purchase of water	-	0.43	300.00
Total Variable Cost (TVC)			8,553.60
Total cost $TC = (TVC + TFC)$			8,941.60
$\boldsymbol{TVP}$	**494**		**11,875.00**

Table 2: Continue

Fixed Cost (Production phase 5)			
Depreciation cost of fixed inputs		-	350.00
Total Fixed Cost (TFC)			350.00
Variable cost			
Feed (starter, grower and finisher)	-	8.09	5,668.00
Purchase of DOCs	700	3.00	2,100.00
Veterinary drugs	-	0.71	500.00
Purchase of water	-	0.57	400.00
Total Variable Cost (TVC)			8,668.00
Total cost $TC = (TVC + TFC)$			9,018.00
$\boldsymbol{TVP}$	**667**		**17,342.00**
Fixed Cost (Production phase 6)			
Brooder and permanent structure	-	-	29,313.78
Depreciation cost of fixed inputs	-	-	350.00
Total Fixed Cost (TFC)			29,663.78
Variable cost			
Feed (starter, grower and finisher)	-	11.31	15,613.29
Purchase of DOCs	1380	3.80	5,250.00
Veterinary drugs	-	3.79	5,240.03
Purchase of water	-	0.33	450.00
Total Variable Cost (TVC)			26,553.32
Total cost $TC = (TVC + TFC)$			56,217.10
$\boldsymbol{TVP}$	**1369**		**36,963.00**
Fixed Cost (Production phase 7)			
Depreciation cost of fixed inputs	-	-	300.00
Total Fixed Cost (TFC)			300.00
Variable cost			
Feed (starter, grower and finisher)	-	1.20	18,000.00
Purchase of DOCs	1500	4.80	7,200.00
Veterinary drugs	-	2.47	3,700.00
Purchase of water	-	0.30	450.00
Total Variable Cost (TVC)			29,350.00
Total cost $TC = (TVC + TFC)$			29,650.00
$\boldsymbol{TVP}$	**1458**		**40,824.00**
Fixed Cost (Production phase 8)			
Depreciation cost of fixed inputs	-	-	300.00
Total Fixed Cost (TFC)			300.00
Variable cost			
Feed (starter, grower and finisher)	-	16.53	36,351.00
Purchase of DOCs	2199	4.80	10,560.00
Veterinary drugs	-	2.92	6,431.00
Purchase of water	-	0.45	900.00
Total Variable Cost (TVC)			54,242.00
Total cost $TC = (TVC + TFC)$			54,542.00
$\boldsymbol{TVP}$	**2097**		**75,492.00**

Table 3: Broiler profitability analysis per production phase

Unit	Output	APP	AVP	TVP	TFC	TVC	TC	π
8.92	475	53.25	958.50	8550.00	2500.00	4459.00	6959.00	**1591.00**
11.17	668	59.80	1196.00	13360.00	3375.00	7818.18	11193.18	**2166.82**
11.93	677	56.75	1248.50	14894.00	400.00	8453.60	8853.60	**6040.40**
12.36	494	39.97	999.25	11875.00	388.00	8553.60	8941.60	**2933.40**
12.37	667	53.92	1401.92	17342.00	350.00	8668.00	9018.00	**8324.00**
19.23	1369	71.19	1922.13	36963.00	29663.78	26553.32	56217.10	**-19254.00**
8.77	1458	166.25	4655.00	40824.00	300.00	29350.00	29650.00	**11174.00**
24.70	2097	84.89	3056.04	75492.00	300.00	54242.00	54542.00	**20950.00**

CONCLUSION

Results obtained from the study indicate that broiler production at the BNARI farm is profitable and efficient at all the various phases of production except at the sixth phase where profitability was negative due to additional fixed cost incurred on the construction of a bigger brooder and permanent houses. The study also showed that though variable feed cost was high coupled with the volatility in prices of other production inputs, broiler production at the BNARI farm was still profitable. Results obtained from the study can be useful for individuals as well as corporate organizations planning to undertake broiler production as a business on a large scale for a profit motive granted all other things being equal.

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