COMPARISON OF PRODUCTION EFFICIENCY BETWEEN SOLE AND INTEGRATED BACKYARD CHICKEN PRODUCTION SYSTEMS: A CASE IN VAVUNIYA DISTRICT

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Abstract

The variety of benefits in backyard chicken operations have been widely elaborated under varying production contexts. However, the efficiency in management and resource utilization are not assessed properly. Therefore, the present study focused on the production efficiency between sole (BC-sole) and integrated (BC-integrated) operation systems of backyard chicken in Vavuniya district. The proportionate sample selection was done according to the backyard chicken populations found in respective Divisional Secretariat Division (DSD). A total of 100 farmers were selected, representing fifty each from BC-sole and BC-integrated systems from four DSDs. Production efficiency was assessed by benefit cost analysis and Returns to Scale operation concepts. The Returns to Scale was estimated by log – log regression where Cobb-Douglas function was assumed. The Benefit Cost ratios of BC-sole and BC-integrated systems were 1.46 and 3.92, respectively. Efficient and effective management was observed in the BC-sole system with increasing number of flocks. The Returns to Scale for BC-sole system was 1.13, and for BC-integrated it was 0.75, suggesting opposite directions in scales of operations for the two systems. Therefore, the efficiency in the long run with increasing input level could be warranted for BC-sole system. It was concluded that BC-sole system was beneficial for large flock in long run and BC-integrated system was beneficial for small flock in short run. This study will be helpful for decision making in promoting and scaling up backyard chicken systems.

Keywords: *Production efficiency; backyard chicken; Benefit Cost ratio; Returns to scale*

INTRODUCTION

The contribution of Backyard Chicken (BC) was discussed in many occasions under Sri Lankan context (Weerahewa, 2010; Abeykoon et al., 2013, Bett et al., 2014). The BC rearing system is an integral part of the crop-livestock integrated farming system in all parts of Sri Lanka (Manjula et al., 2018). Indigenous chicken contribute approximately 15% to country's egg production, and having the population size of around 0.93 million representing around 2.5% of the total chicken population in the country (DAPH, 2019). Describing the BC rearing systems, Wijesena et al. (2014) pointed out that a variety of indigenous types of BCs are mostly found as semi-scavenging flocks, where scavenging is allowed during the day-time. BC production systems vary in accordance with local resource, producer preferences, household residential circumstances and climatic conditions. Though there are range of variations it could assume that all production systems were homogenous with similar production objectives and management interventions (Mahoro et al. (2017). The flexibility of the system and efficient utilization of available resources are the key in sustainability of BC operations for decades or probably for

centuries. However, the efficiency in management and resource utilization are not assessed adequately in many instances. Therefore, the present study focused on the production efficiency of two different production operations of BC (BC-sole and BC-Integrated) in Vavuniya District, which is one of the areas the BC production is emerging with interventions during post-conflict era.

MATERIALS AND METHODS

The study was conducted in Vavuniya District)t (8.7542 ºN, 80.4982 ºE) in Northern Province of Sri Lanka where the annual rainfall is around 300 mm and ambient temperature is 25 – 30 ℃ on average. The District is divided into four divisional secretary (DS) divisions; i.e. Vavuniya, Vavuniya north, Vavuniya South and Vankalacheddikulum (Figure 1). The livelihood of majority of dwellers is farming, including both crop and animal agriculture, where rearing BC is prominent.

Sampling method

Proportionate sampling was carried out as indicated in Table 1 covering four DS divisions. A total of 100 families from 16 villages were included in the study. The families were purposively selected from each village foe equally represent BC-sole

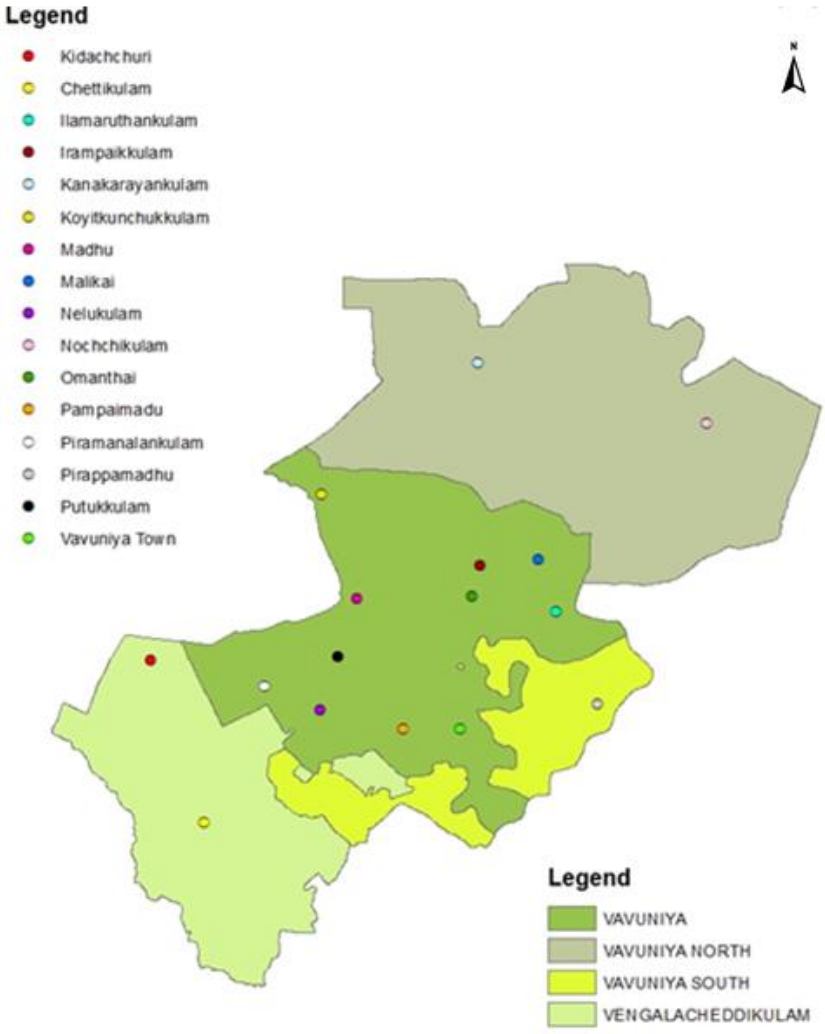

Figure 1: The study area of the Vavuniya district and the villages used for data collection

production system where BC was the only component in the animal farm, and BC-integrated production systems where BC is reared together with other livestock (cattle and/or goats) which are kept under semi-intensive production system.

Data collection

A pre-tested structured questionnaire was used for data collection in a single visit survey. The questionnaire was structured to collect household information (family members, education, level of education), socio-economic information (occupation, expenditure, farm revenue) and production status (purpose of rearing. Husbandry information, different produces, processing).

Table 1: Details of sampling arrangement

DS Division	Total BC population in each division	Number of villages included in the study	Families from each village	Number of e farms studied
Vavuniya	49504	11	6	66
Vavuniya North	10518	2	7	14
Vengalakchcheddikulam	11546	2	7	14
Vavuniya South	3789	1	6	6
Total	75357	16	-	100

The information collection was done by one enumerator to avoid biases and carried out as face-to-face interviews. Personal observation of the enumerator regarding the farm condition and operation were also noted at the end of the interview.

Data analysis

Demographic analysis, return-to-scale and benefit-cost analysis were carried out using statistical package STATA version 11.0 following procedures described below. The socio-economic characteristics were compared using the descriptive statistics.

Return to scale

The return to scale, was estimated by linear log regression model by assuming Cobb – Douglas production function (Black et al., 2009) as indicated by Eq. 1 and Eq. 2. Production unit was considered as dependent variable and all input cost and units were used as independent variables. By estimating the coefficient of each variable and summing up all input coefficients, the return to scale was calculated as depicted in Eq 3 (Black et al., 2009).

Cobb – Douglas function – $Y = X1\alpha1 + X2\alpha2 + X3\alpha3$ ---------- Eq. 1

Linear log regression model – $\ln Y = \alpha1 \ln X1 + \alpha2 \ln X2 + \alpha3 \ln X3$ ---------- Eq. 2

Thus,

Production (Y) = f (input cost(X1))

Production = f (feed cost, medicinal cost, electricity, labor cost, transport, shed cost, service cost, litter cost)

Returns to scale = $\alpha1 + \alpha2 + \alpha3$ ------Eq. 3

Benefit Cost ratio

The following function (Eq. 4) was used to determine the B/C ratio of the production.

Benefit Cost Ratio = $\frac{B_t}{C_t}$ ----------Eq. 4

Where,

B_t is the value of benefits earned in t time period

C_t is the cost incurred in t time period

RESULTS AND DISCUSSION

Socio-Economic characters of the farmers

The socio-economic characteristics of BC farmers of the present study have been evaluated through age distribution, gender distribution, education level, occupation, income level and household size. The summary of socio-economic parameters in BC-sole system and BC-integrated system is presented in Table 2.

Gender Distribution

Majority of farmers (60%) were females in BC-sole system whereas the majority (64%) were males in BC-integrated system. A high involvement of females in BC rearing has been documented in several occasions (Tufail et al., 2012; Bett et al., 2014, Abdhani et al., 2019). However, the present findings indicated that male participation is prominent when other farming activities such as crop cultivation, livestock farming are integrated with BC. The reason for this finding could be that when male farmers are engaged in the livestock rearing, it is considered as their major income generation or employment in which context the BC-sole system is considered as a part time engagement. In contrast, females labor is readily available to involve in an additional income generation activity (Thiini et al., 2016, Mahoro et al., 2017).

Table 2: Socio-economic characteristics of farmers of BC-sole and BC-integrated systems

Parameter	Backyard Chicken – sole system	Backyard Chicken – Integrated system
Average age of farmer (yrs)	46.3 ±23.0	47.7 ± 21.1
Family size	3.98 ± 1.6	3.94 ± 1.8
Gender	60% female	64% male
Educational level	94% secondary education	96% secondary education
Chicken farming as major occupation	50%	40%
Mean monthly income from backyard chicken (Rs.)	23,540.00	16,700.00

Age Distribution

Majority of the farmers in BC- sole (46%) and BC -integrated (40%) are relatively older (>50 years). According to the survey information the reasons for the elders to be engaged in farming are the availability of less employment opportunities in the area, and free time. This trend of age is also reported by several authors (Tufail et al., 2012; Bett et al., 2014; Mahoro et al., 2017).

Education Level

The secondary level education is a key characteristic of the farming community of both the systems (94% - 96%). The implication here is that, irrespective to the system, the backyard chicken rearing has become a livelihood support opportunity for farmers, those who are having education level which is not competitive enough for wage earning engagement. Though the

education level reported in the present study is higher compared to 7.5% secondary level education reported for a region in Pakistan (Tufail, 2012) and comparable for the other regions of the country (Thilini et al., 2016), this observation implies that it will hinder bringing innovation for production improvements in BC in the rural areas due to lack of motivation knowledge seeking..

Major Occupation

Between the two BC production systems, a high proportion of farmers under BC-sole system (50% compared to 40% in BC-integrated) considered that chicken farming as their major occupation (Table 2). The other occupations the farmers engaged in were paddy cultivation, public sector employment, self-employment and daily waged earning activities. BC-integrated system also followed the similar pattern of employment. Compared to BC-sole system, a less proportion of farmers was engaged in chicken farming as major occupation. Further, compared to BC-sole system, a high proportion of farmers (37%) were engaged in paddy cultivation in BC-integrated system. This observation could justify the fact that the paddy farming and livestock rearing get several mutual benefits owing to the compatibilities in labor utilization, nutrient recycling,income generation and even drought power. Therefore, the present observation of more involvement in paddy farming in BC-integrated system could be justified.

Income Distribution of farmers in the two BC systems

The present study indicated that most of the farmers (92%) in BC-sole system had more than Rs.10,000 monthly income, and among them around 35% of farmers fell under the category of more than Rs.25,000 per month. In contrary, around 46% farmers in BC-integrated system drew the monthly income of Rs. 5,000 – 10,000 from all livelihood activities. The results suggest that high income earners tend to engage in BC-sole system drawing more engagement of females while male partner could engage in another income generating activities. Thus, the income levels of farmers in BC-sole system were recorded higher than that in BC-integrated system in the present study (Figure 2).

Economic benefits of backyard chicken operation

Economic profitability of farming is one of the main indicators to understand the economic efficiency of two BC systems. Between the two systems the income sources were found to be different, and the benefits varied accordingly. In both the systems, paddy cultivation, public sector employment, self-employment and daily waged earning activities are the other income sources that the farmers were engaged in.

In BC-sole system farmers gain low income per chick compared to that in BC-integrated system operation (Table 3). This could be probably due to advantageous farming conditions for chicken rearing in BC-integrated system. In BC rearing, farmers do not tend to spend money on formulated feed. According to the present investigation, in BC-integrated operation, chicks have high chances to receive a variety of feeding materials such as feed residues of other livestock and crop residues (if it is with crop integration). Thus, a high income per bird has been recorded in BC-integrated system than in BC-sole system.

The products of BC are sold either at market or at household level. Most of the farmers in both farming systems indicated that they have an opportunity to sell their products at high prices at the market, compared to the selling at household level. Between the two faming systems

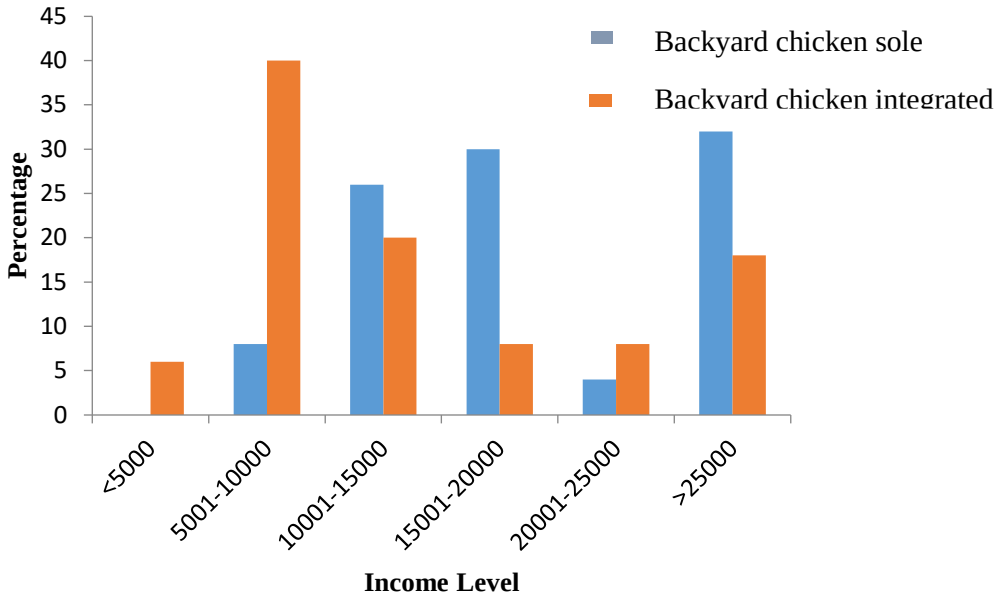

Figure 2: Income level distributions of backyard chicken rearing farmers

Table 3: Comparison of average income of the two BC systems

Variable	BC-sole system (Rs)	BC-integrated system (Rs)	Significance
Monthly Egg income	515.88	653.75	Pr (| T | > | t |) = 0.00
Meat income per bird	949.11	1028.25	Pr (| T | > | t |) = 0.07

BC-integrated farmers have fetched a high unit price for their products (Table 4). Diverse farm products such as meat, dairy produce, byproducts like manure (even crop produce) are available in BC-integrated system might also have created opportunities for farmers to bargain to receive a high price. This is in addition to the extra income BC-integrated farmers earn by selling other farm products (Table 5). Thus, the BC-integrated system exhibited more market orientation than the BC-sole system.

Production cost

Table 6 provides the different cost categories incurred in the production of the two BC farming operations, whereas Table 7 summarizes the total cost per bird. The mean total cost of one bird in BC-sole and BC-integrated systems were Rs. 1004.85 and Rs. 428.55, respectively. The cost per bird in BC-sole system is way too high in the present study. However, the farmers of the BC-sole system in the study location tends to feed them with commercial formulations. However, the cost is high particularly in BC-sole system compared to BC-integrated system, as feed supplementation in BC-integrated is compensated by feed residues from other livestock species integrated in the system. Though feeding costs represented the major variable cost in both farming operations, the BC-integrated system carries recycling

Table 4: Comparison of income sources in BC systems

Income source	BC-Integrated		BC-Sole	
	Number/ month	Unit Price (Rs)	Number/ month	Unit Price (Rs)
Egg sold at household level	15	16.29	7	16.00
Egg sold at market level	23	17.80	23	17.56
Female chicken meat	1	857.14	1	795.83
Male chicken meat	1	1169.36	1	1102.38

Table 5: Annual average livestock income in BC-integrated system

Income sources	Mean (Rs)	Min (Rs)	Max (Rs)
Annual income from Beef	49,900.00	0.00	1,200,000.00
Annual income from Goat meat	37,320.00	0.00	625,000.00
Annual income from Cattle manure	13,097.14	1,440.00	36,800.00
Annual income from Goat manure	1,975.24	200.00	16,400.00
Annual income from Cow milk	22,242.20	0.00	37,920.00

opportunities and synergetic features in the system operation.

When the total cost among two farming operations were compared, the farmers in BC-sole system were spending high cost per chick, particularly for feed, transport and labour. In BC-integrated system however, these costs were minimum or no cost involved at all, as those costs are compensated or absorbed by the other livestock activities. Thus, the costs involved in these categories are shared with other categories of the integrated operation, and has no special cost identified only for backyard chicken operation. Therefore, the cost for backyard chicken is low.

Benefit cost analysis

In cost-benefit analysis, benefit-cost ratio (BCR) is an indicator that is used to evaluate the efficiency of the operation. A BCR can be a profitability index in industrial contexts where it takes into account the amount of financial gain realized by performance against the total cost to whole farming activity (Hadas et al., 2021). When the BC-Sole and BC-integrate systems were compared, the BCR is higher in the integrated operation.

As depicted in Tables 6 and 7, a high benefit and low cost were observed in the BC-integrate operation compared to BC-sole system. Thus, high BCR is possible in BC-integrated system. The comparisons of BCR in the two systems is shown in the Table 8. When the range of BCR was considered, BC-integrated system varied within a broader and higher range (2.33) than did BC-sole operation (1.79). This observation implies that some farmers in BC-integrated systems manage the resources efficiently depicting the potential of using the integration effectively with the integrating. However, these values are less than the undiscounted benefit cost ratio of 5.57 calculated by Uddin et al. (2013) for native chicken in three coastal districts in Bangladesh. Benefit and cost are varying with the number of chicks. Between BC-sole and -integrated systems, the gain per Rupee increased with increasing number of chicks in the sole system but it was opposite

in integrated system. That was clearly described in the Figure 3. In the practical scenario, difficulty in managing flock with livestock could increase with the increasing

Table 6: Descriptive statistic of production cost per bird

Cost (Rs.)	BC-Integrated			BC-Sole		
	Mean	Min	Max	Mean	Min	Max
Shed cost	230.67	125.60	345.23	330.32	225.00	435.56
Veterinary cost	24.07	0.00	54.32	45.07	0.00	67.87
Labor cost	26.34	0.00	54.34	36.98	0.00	87.79
Electricity cost	0.00	0.00	0.00	0.00	0.00	0.00
Litter cost	1.80	0.00	2.13	1.80	0.00	2.34
Transport cost	0.00	0.00	0.00	23.34	12.21	67.89
Feed cost	145.67	0.00	378.90	567.34	203.10	798.78

Table 7: Descriptive statistic of cost per bird

Cost per bird	Mean	Min	Max
Total cost per chick in BC-sole system	1004.85	440.31	1460.23
Total cost per chick in BC-integrated system	428.55	125.60	834.92

Table 8: Benefit-cost ratio of the two BC systems

Benefit cost ratio	Mean	Min	Max
Benefit cost ratio of integrated backyard operation	3.92	1.79	4.12
Benefit cost ratio of sole backyard operation	1.46	0.50	2.29

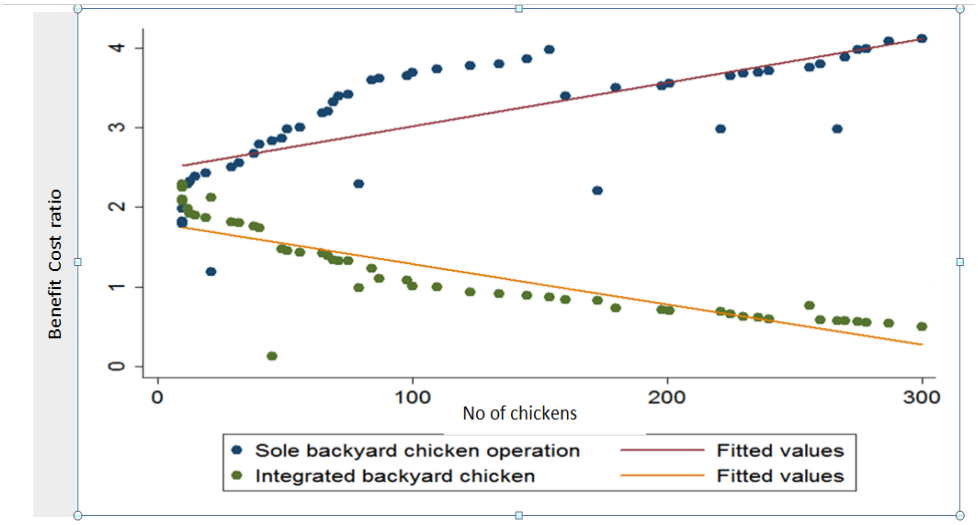

Figure 3: Relationship between Benefit Cost ratio and number of chickens

flock size. Further, attention given to chicken in BC-integrated operations could also be low. In contrary, large flocks tend to be kept by farmers who can pay good attention under BC-sole system, in which case the production tends to be high. Large flock size also contributes to increase feed efficiency leading to less per bird cost. Thus, an efficient and effective management is observed with large flock in the BC-sole operation.

Return to Scale between BC-Sole and BC-Integrated systems

The efficiency in the production of operations in long run can be understood through analyzing the Returns to Scale (RTS) which explains how output response to increase or decrease in all inputs together. Very often, the concept of RTS is used to measure the consequence of the quantity changes in the production. In adopting this concept to compare BC-sole and BC-integrated systems, the Cobb Douglas production function was assumed, and returns to scale operation was calculated according to log-log regression. Descriptive statistic depicted in Tables 4 and 5 were the variables used in the regression. Prior to the regression analysis, the significant differences (P=0.0069) in production between two systems was ensured by mean comparison (Table 9).

The results of the regression and RTS analysis of the two systems are shown in Tables 10 and 11. According to the regression results the production function is ensured with 82.3% R^2 value for integrated farm and 75.5% R^2 value for sole backyard chicken farm where 82.3% of the variability in the log production is explained by the log transformed feed and shed cost in BC-integrated system. Similarly, 75.5% of the variability in the production function is explained by the labour in BC-sole system. In BC-integrated system, one percent increase in feed cost and shed cost would increase the production, respectively by 0.51% and 0.24%. However, in the BC-sole system, labour cost was the only significant variable, one percent increase of which tend to increase the production by 1.13%.

The three variables found significant (Table 10) in the two BC systems (shed and feed costs in BC-integrated system and labour

Table 9: Mean comparison test for production

Farm type	Mean of log transformed production
BC-sole system	10.64 (0.17)
BC-integrated system	11.21 (0.11)

Table 10: Regression coefficients obtained for the two BC systems

Variables	Integrated backyard chicken Coefficients	Sole backyard chicken Coefficients
Veterinary cost	0.007 (0.62)	0.02 (0.17)
Labour cost	0.290 (0.17)	1.13 (0.44)*
Feed cost	0.510 (0.08)*	0.27 (0.25)
Shed cost	0.240 (0.07)*	0.33 (0.22)

* Significant at P<0.05

Table 11: Returns to Scale of the two BC systems

Farm type	Return to scale	Farm efficiency in long run	Significant level
Sole backyard chicken	1.13 (0.44)	Increasing returns to scale	0.0419
Integrated backyard chicken	0.75 (0.15)	Decreasing returns to scale	0.0000

cost in BC-sole system) were used in calculating RTS in the respective BC system (Table 11)

Accordingly, the production function of BC-integrated system is as follow
Ln Production = 0.51 Ln Feed cost + 0.24 Ln Shed cost
Therefore RTS: 0.51 + 0.24 = 0.75

Similarly, the production function of BC-sole farming is expressed by
Ln Production = 1.13 Ln Labour cost
Therefore RTS: 1.13

According to the results given in Table 11, the BC-sole system is identified with the increasing returns to scale whereas BC-integrated system was identified with the decreasing returns to scale. This implies that BC-integrated operation tends to show less increase in production with the increasing input levels in the long run. For instance, when all input level was increased by 1% production would increase by 0.75%. In contrast, in the BC-sole operation with increasing level of input, the production level will increase by more than the input increase level in the long run. Thus, if all inputs were increased by 1%, the production would increase by 1.13%. Therefore, between the two BC systems in the study population, BC-sole system is more beneficial for large scale production than the BC-integrated system.. As pointed out by Uddin et al. (2013), increasing returns to scale indicates that there was bright prospect to earn more through the use of more inputs in the production process. However, according to the current scale of operation in the study site, the BC-integrated system is more efficient than BC-sole system as depicted by the results of the present study.

CONCLUSIONS

Findings of the present study suggested that the backyard chicken-sole system is beneficial for large scale operations in the long run whereas the backyard chicken-integrated system is beneficial for current scale of operation with small flock size where the resource utilization is more efficient than the backyard chicken-sole system. This study will be helpful for decision making in promoting and scaling up backyard chicken systems.

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