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ON-FARM EVALUATION OF HAY BOX BROODER EFFECTIVENESS ON SASSO AND INDIGENOUS CHICKS

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted in South Gondar Zone to evaluate the effectiveness of hay-box chick brooder under rural farming condition with the use of Sasso and Indigenous day old chicks. Based on their voluntariness to construct the hay box brooder, fifteen households were selected purposively. A total of 150 indigenous and 450 Sasso T-44 day old chicks were divided equally in to 15 groups each with 10 indigenous and 30 Sasso day-old chicks. The Sasso groups were active and vigorous after the first week of hay box brooding: whereas the indigenous groups were found to be difficult to adapt to the hay box brooding environment and characterized by dull appearance, noisy voice/sound, huddling together, wing dropping, poor feed and water consumption and stunted growth throughout the brooding period. About 85 and 50% of Sasso and indigenous chicks survived at 8 weeks of age of hay box brooding respectively. Hay box brooding technology is effective in rising exotic baby chicks under rural Ethiopian conditions as compared to the performance of natural brooding. On the contrary, the survival rate of indigenous chicks assigned to the hay box brooder was comparable to that of natural brooding. Therefore, it seems that the hay box chick brooding technology is not adequately effective in raising indigenous chicks as measured by chick growth performance and rate of survival 8 weeks of age.

Keywords: Adaptability; brooding; growth rate; mortality; poultry.

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1. INTRODUCTION

In the rural area of Ethiopia, chicks are used for natural incubation and natural brooding that are hatched and raised. A broody hen protecting, rearing and hatching few number of chicks (6-8) ceases egg laying during the entire incubation and brooding periods of 81 days. However, the successes of the brooding process and hatching depends on the maternal character of the broody hen and prevalence of predators in the area. The major causes of premature death of chicks in the rural areas are wild animal, birds of prey and pets [1]. The mean survival rate of baby chicks reared under natural brooding condition in Ethiopia is about 40% at age 3-months [2,3], indicating that the broody hen ceases egg laying for 2.7 months for the purpose of rearing 2.8 chicks to an age of 3 months.

The young chicks are unable to maintain their normal body temperature without the aid of supplementary heat. Baby chicks are impotent to live for any length of time without an additional source of heat other than their own bodies as compared to most other small animals. This baby chick's brooding refers to the early periods of growth (0-8 weeks). Under natural condition, broody hens lay and brood their eggs until they hatch and continues rearing the chicks through provision of the needed warmth and protection against predators. Artificial brooding refers to some type of heated enclosure for raising baby chicks and artificial brooders include provision of food and water, heat lamp, and bedding materials [4,5].

There are different artificial chick brooders which available of every conceivable size and type, that heated by coal, oil, water, gas, hay box brooder and electricity. With the exception of the hay box brooder, all other methods are difficult to operate with local skills in rural areas. The others are not maintain constant brooding temperature and electricity is require high foreign currency for importation and are expensive in size of less than 1000 chick capacity. Yet, hay box brooder are easily be constructed, could safely, economically feasible and maintain the desired constant brooding temperature. Unfortunately however, it is difficult to adopt electric brooders by the African rural household poultry producers owing to the unavailability of electric power, numbers of chicks to be raised and remote locations of the farm sites [1]. According to [1], hay-box chick brooding technology in which no artificial heat is employed seems to be a brooder of choice by small scale poultry producers in Ethiopia. The hay-box chick's brooder is an appropriate and simple technique that could be used to raise day-old chicks at the village level that developed by Jimma University College of Agriculture and Veterinary Medicine (JUCAVM). The technology could be constructed from locally available materials and keeps the chicks warm through conservation of their metabolic heat [4]. The hay box brooder protects against predator attacks and expected to reduce the risk of disease infection through confinement [5]. These being the cases, the objective of this study was to evaluate the effectiveness of hay-box chick brooder under rural farming condition with the use of Sasso breed and Indigenous day old chicks.

2. MATERIALS AND METHODS

2.1 Selection of Participating Household

Fifteen households were purposively selected based on their voluntariness to construct the hay box, handling it properly and meet the criteria of the researcher. The selected households were grouped in to three categories i.e educated, experienced and neither educated nor experienced. The participating households were selected from Kakkal and Modelbet Peasant Associations (PA) located in Hiruy Abaregay. The selected farmers were trained in the construction & management of hay box brooder including proper handling, feeding, and record keeping (data collection). Similar starter's ration and hay box brooder of equal capacity were used in the brooding process of the experimental chicks by the participating households with close and regular supervision of the researcher.

2.2 Construction of the Experimental Hay Box Brooder

The constructional design and specification of the hay and running box used in the study area is shown in Fig. 1 and Table 1. The construction of the hay-box brooders were done according to the constructional design and specifications of suggested by [4]. The boxes constructed consisted of four outer frame boards, each with four 2.5cm diameter ventilation holes (16 holes/box) drilled at the top. The floor of the box was made up of half-inch mesh wire netting, tightly stretched to prevent drooping. The top of the box was covered with a stack of hay, and hay was stuffed between the sides of the box and the central nest. Hay box brooder of 10 and 30 chicks capacity were constructed and two hay-box brooders one for indigenous and one for Sasso breed were offered to each of the 15 selected participating households, respectively. The hay-box brooder of 10 and 30 day old chicks was implemented to brood indigenous and Sasso T44 breed of chicks.

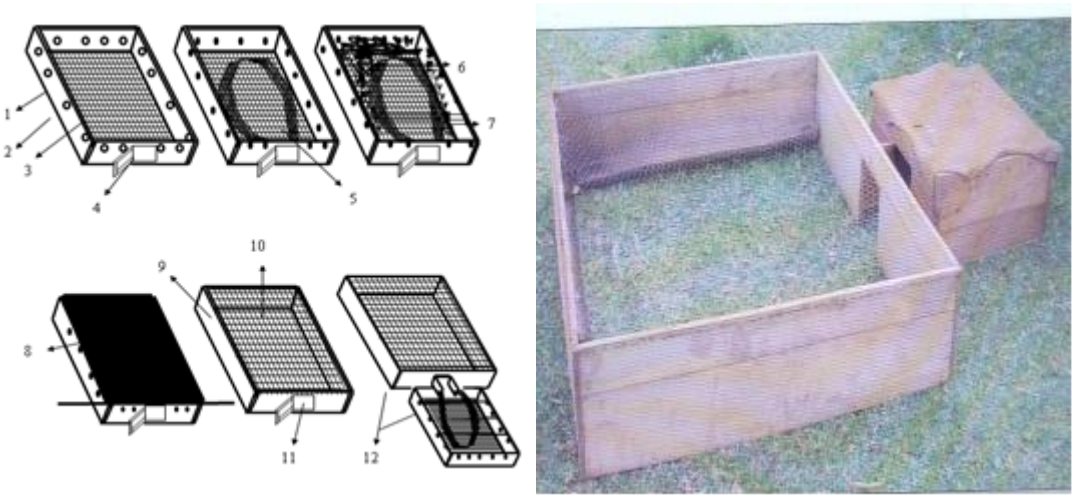

Fig. 1. Construction design of the hay-box and run

1= frame board, 2 = Ventilation hole, 3 = mesh-wire floor, 4 = door, 5 = central nest, 6 = stuffed hay, 7 = stick, 8 = sack filled with hay, 9 = run frame board, 10 = mesh-wire, 11 = run door, 12 = box and run arrangement

Table 1. Specification of the hay box brooders and runs designed to brood batches of 10-30 day old chick's height, width and length

No. of chicks	Box Dimensions (cm)	Run Dimension (cm)
10	26 x 26 x 30	56 x 56 x 30
20	37 x 37 x 30	80 x 80 x 30
30	45 x 45 x 30	98 x 98 x 30

2.3 Experimental Chicks Management

The experimental procedure was reviewed and approved by Debre Tabor University Research Ethics Committee (Ref. No. DTU10/20) and it was conducted by qualified and experienced personnel under the supervision of a veterinarian, according to the guidelines of the World Organization for Animal Health. A total of 150 indigenous and 450 Sasso T 44 day old chicks were used to evaluate the effectiveness of the hay-box brooders. Each of these were divided equally in to 15 groups each with 10 indigenous and 30 Sasso day-old chicks. These were randomly assigned to the 30 hay box brooders (15 of 10 and 30 chick's capacity) for study period of 8 for Sasso and 24 weeks for indigenous chicks. All the day old chicks were placed on similar starter's ration during the first 8 weeks of brooding. At an age of 8 weeks, the experimental chicks were switched to grower's ration and the study was extended up to an age of 24 weeks. At the beginning of the study, initial body weight of the baby chicks was recorded and body weight was measured weekly. Finally, the final body weight of the experimental chickens were recorded to determine the rate of growth performance with the use of locally constructed hay box brooder. Mean growth rate, survival rate, adaptability and partial budget analysis were considered to be the major evaluation parameter of the effectiveness of the hay box brooder under rural farming conditions.

2.4 Data Collection

2.4.1 Growth rate

The growth rate of the experimental chicks was measured as weekly by using sensitive balance with 7kg weight capacity in 1gm precession. The mortality rate of chicks was determined by using two types of calculation mechanisms [6]. The chicks' (less than one month of age) mortality rate (CMR) was mathematically expressed by equation 1 as;

$$\text{CMR}\ (\%) = \frac{\text{NCD}}{\text{TNC}} * 100 \qquad (1)$$

Where TNC means the total number of chicks hatched during at that period and NCD means the number of chicks that died during the observation period. The overall (chicks + adult poultry) mortality rate (MR) was mathematically expressed by equation 2 as;

$$\text{MR}\ (\%) = \frac{\text{TNCD}}{(\text{FB} + \text{TNC} + \text{CP})} * 100 \qquad (2)$$

Where TNCD is the total number of chickens (chicks and adults) which died during the observation period, FB means the flock size at the beginning of the observation period and CP means the total number of chickens purchased during the observation time.

Hay box brooder technology performance evaluation is depending on the survival rate of chicks. The survival rate was also determined based on the number of chicks at the end of the experiment and at the beginning of the experiment (Equation 3).

$$Survival\ rate\ (\%) = \frac{Number\ of\ chicks\ at\ the\ end\ of\ experiment}{Number\ of\ chicks\ at\ the\ begining\ of\ experiment} * 100 \quad (3)$$

2.5 Partial Budget Analysis

The partial budget analysis was determine the economic benefit of hay box brooder technology in rural communities [7]. The total variable cost considered in this study includes the cost of chicks and health costs whereas the construction material cost for hay box brooder production was taken as a fixed cost during the experiment for each treatment group. The Total Return (TR) was considered as a difference in the sale and purchased price. The net income (NI) was expressed by subtracting total variable cost (TVC) from the total return (TR) (equation 4).

$$NI = TR - TVC \quad (4)$$

The change in net income (ΔNI) expressed as the difference between the change in total return (ΔTR) and total variable cost (ΔTVC) mathematically represented as;

$$\Delta NI = \Delta TR - \Delta TVC \quad (5)$$

The marginal rate of return (MRR) measures the increase in net income (ΔNI) related to each additional unit of expenditure (ΔTVC) and expressed in the percentage (equation 6).

$$\%MRR = \frac{\Delta NI}{\Delta TVC} * 100 \quad (6)$$

2.6 Statistical Analysis Methods

All the collected data were analyzed by using the Statistical Analysis System (SAS) 9.2 version [8]. A General Linear Model (GLM) procedure was fitted to some parameter that was appropriate for analysis. Descriptive statistics was utilized to summarize data on morbidity and mortality. Chi-square test statistics were employed to see whether there is any significant difference in morbidity and mortality of the two different ecotypes.

3. RESULTS AND DISCUSSION

3.1 Chicks Growth Rate

The results of weekly and overall growth performance of the experimental Sasso breed and indigenous day old chicks are presented in Figs. 2 and 3 respectively. The results obtained indicated that, Sasso breed chicks had faster growth rate than that of indigenous chicks when raised with the use of hay box brooder. Mean live body weight of 890 g/h was attained by the Sasso chicks at an age of eight week (at the end of brooding period), as compared to the mean body weight of 235g/h attained by the indigenous chicks at the similar age.

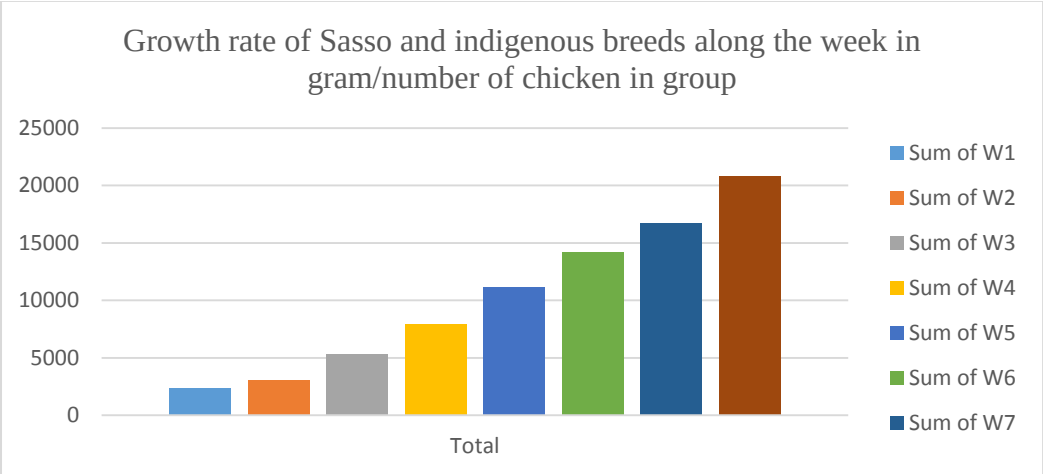

Fig. 2. The total growth of Sasso and indigenous breeds along the week

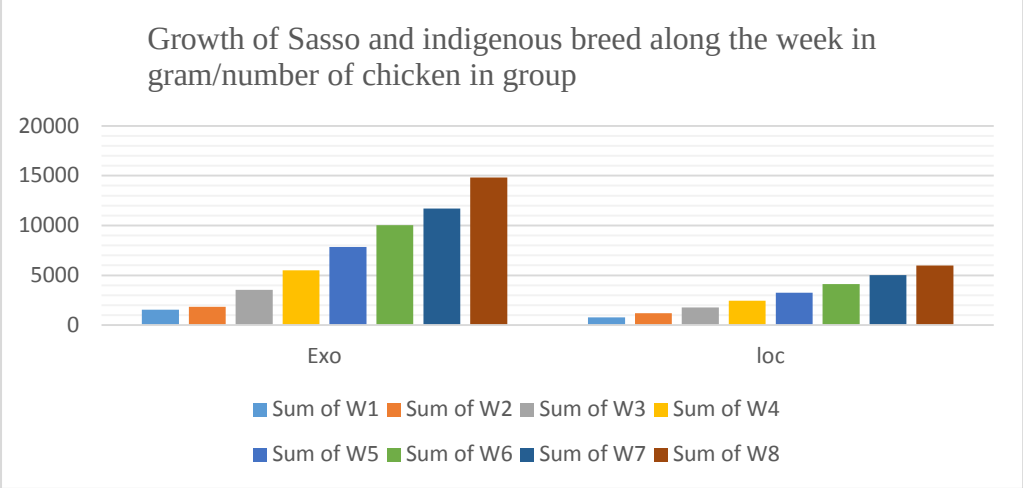

Fig. 3. Sasso and indigenous breed growth in different weeks

As shown in Fig. 4, the baby chick of the Sasso breed showed a tendency of huddling at the corner of the hay box brooder and showed less interest in their environment including low rate of water and feed consumption during the first week of hay box brooding. These groups were active and vigorous after the first week of hay box brooding. The results obtained indicated that hay box brooder seems to be effective in raising Sasso breed day old chicks under rural farming conditions compared to the raising of indigenous chicks.

On the contrary, the indigenous chicks were found to be difficult to adapt to the hay box brooding environment compared to Sasso breed of chicks. The indigenous experimental chicks assigned to hay box brooder were characterized by dull appearance, noisy voice/sound, huddling together, wing dropping, poor feed and water consumption and stunted growth throughout the brooding period, indicating poor adaptability to the hay-box brooding circumstance. Similar observations were reported by [9,10] from on-farm and on-station evaluation study of hay box brooder with the use of different breeds of day old chicks. The suitability of hay box brooder in brooding different breeds of day old chicks was studied under on-farm and on-station conditions, but studies conducted to evaluate the effectiveness of hay box brooder in raising Ethiopian indigenous baby chicks seems to be rare [11,1,12].

The results of the current study confirm that, the brooding indigenous chicks with the use of hay-box brooder is not promising. The results of this study was agree to [13] who reported that local chickens are considered to be adapted to their scavenging environmental conditions and disease resistant. Unfortunately however, the health status of indigenous chickens kept under the intensive system of management (in confinement) are poorer to exotic chickens. Local chickens kept in confinement were described by a lack of interest in their environment, huddling at the corner, wing droppings, cannibalism and leg weakness. They are also sluggish in rate of feathering and exhibit recurrent an occurrences of disease [13-15].

3.2 Survival Rate of Chicks

The results of the survival rate of the experimental chicks assigned to the hay box brooders are presented in Figs. 5 and 6 and Table 2. The result indicated that the Sasso breed chicks assigned to hay box brooders had significantly ($P<0.001$) higher survive rate than that of the indigenous chicks assigned to the hay box brooders throughout the entire experimental brooding period. The mean survival rate of Sasso chicks distributed to educated households was highly significant ($P<0.001$) than those distributed to experienced and neither educated nor experienced households. This indicated that chicken survival rate had positively correlated with the educational and experience status of the households. There was improvement in the survival rate of Sasso chicks assigned to hay box brooder with advancement of the brooding period.

The results are in agreement with that of [16], who reported that the first two weeks of age are the most critical time of artificial chick's brooding. The results of the survival rate recorded from the hay-box indigenous chicks (50%) in the current study was similar with that of [17], who reported 54.3% of chick's mortality under on-farm evaluation of hay box brooder. The results of the current study tends to indicate that mishandling of the experimental chicks

negatively affected survival rate in some cases. The overall results indicated that about 85% of Sasso chicks survived to an age of 8 weeks of hay box brooding, under rural objective condition of Ethiopia.

In all Ethiopian rural areas, baby chicks are raised by natural brooding. A broody hen is wasted 81 days during the complete incubation and brooding times for hatching, rearing and protective limited number of chicks ceases egg laying. However, the achievements of the hatching and brooding process depends on the maternal instinct of the broody hen and prevalence of predators in the area [1,18,19]. The mean survival rate of baby chicks reared under natural brooding condition in Ethiopia is about 40% at 3-months age [2,3,20]. Thus, about 85% survival rate of the Sasso groups to an age of 8 weeks clearly indicate the effectiveness of hay box brooder in raising exotic breeds of baby chicks in rural Ethiopia. On the contrary, about 50% of the indigenous chicks survived to an age of 8 weeks of hay box brooding, the value of which is comparable to that of natural brooding. Moreover, the indigenous chicks looked stressed under the hay box brooding conditions indicating that the use of hay box brooder in raising indigenous chicks is not effective in rural Ethiopia.

Fig. 4. Sasso breed at beginning and end of first week of brooding

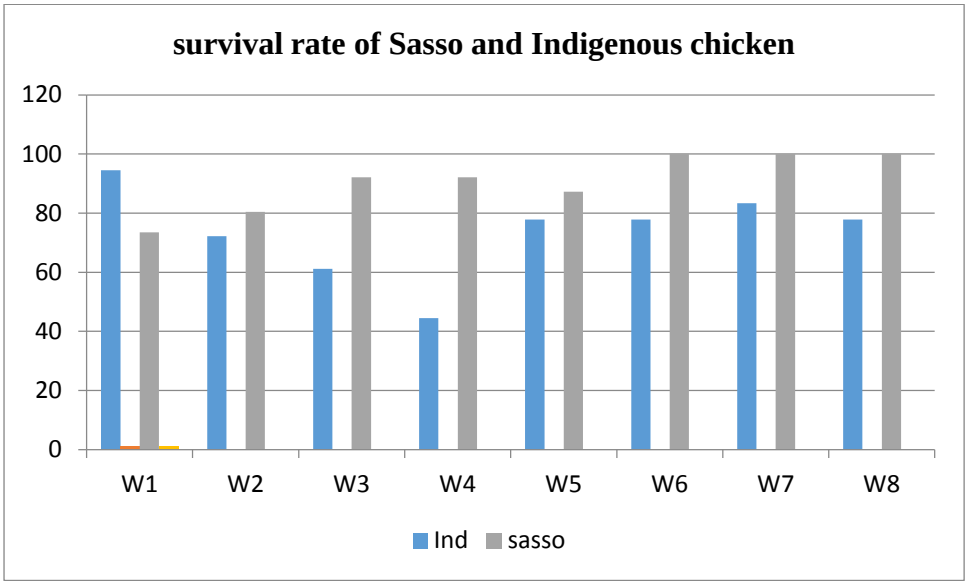

Fig. 5. Survival rate of Sasso and indigenous chicken in different weeks

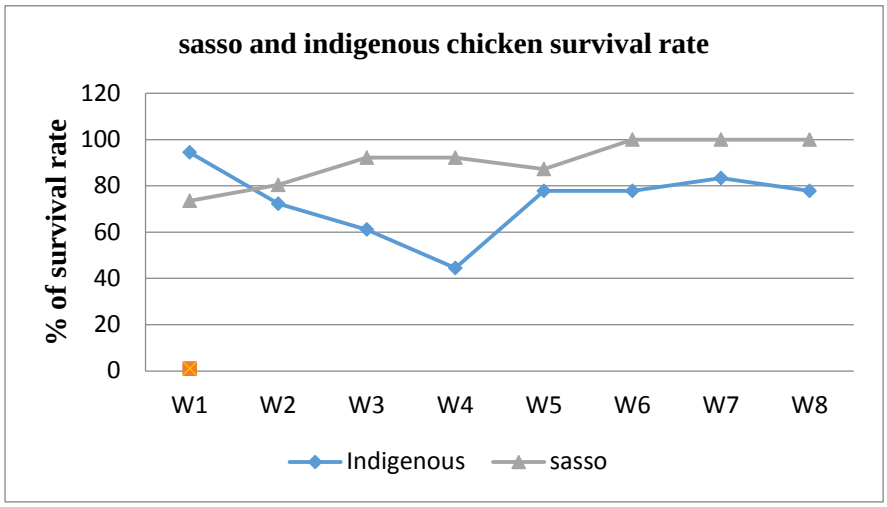

Fig. 6. Survival rate of Sasso and indigenous breeds along with the week

Table 2. The survival rate of Sasso and indigenous breeds under different household groups during 8th weeks experiment

Weeks	Breeds						SEM	Sig.
	Sasso			Indigenous				
	1	2	3	1	2	3		
First week	97.1^{a}	94.1^{a}	85.2^{bc}	88.8^{b}	88.8^{b}	83.3^{c}	3.03	***
Second week	89.2^{b}	87.2^{b}	83.3^{bc}	77.7^{cd}	66.6^{e}	72.2^{de}	2.67	***
Third week	88.2^{b}	86.2^{b}	82.3^{b}	66.6^{c}	44.4^{d}	50.0^{c}	2.53	***
Fourth week	88.2^{b}	84.3^{b}	81.3^{b}	66.6^{c}	44.4^{d}	38.8^{d}	2.55	***
Fifth week	88.2^{b}	84.3^{b}	81.3^{b}	66.6^{d}	44.4^{e}	38.8^{e}	2.17	***
Sixth week	88.2^{b}	84.3^{b}	81.3^{b}	66.6^{d}	44.4^{e}	38.8^{e}	2.04	***
Seventh week	88.2^{b}	84.3^{b}	81.3^{b}	66.6^{d}	44.4^{e}	38.8^{e}	1.80	***
Eighth week	88.2^{b}	84.3^{b}	81.3^{b}	66.6^{d}	44.4^{e}	38.8^{e}	1.07	***

*** P<0.01; *** P<0.001, SEM; standard error of mean; 1=educated household group, 2=experienced household and 3=neither educated nor experienced household groups; Similar letters are indicated the there is no significant difference*

Table 3. Economic feasibility of hay box for chicken production at first production season

Parameter	Sasso breed			Indigenous breed			p-value
	1	2	3	1	2	3	
Running box cost/Eth.br	360^{a}	360^{a}	360^{a}	140^{b}	140^{b}	140^{b}	<.0001
Brooder cost /Eth.br	130^{a}	130^{a}	130^{a}	90^{b}	90^{b}	90^{b}	<.0001
Chicks purchasing cost	929^{a}	929^{a}	929^{a}	60^{b}	60^{b}	60^{b}	<.0001
Vaccination cost	1.01	3.03	2.02	1.1	3.04	2.1	=0.06
Total variable cost/Eth.br	1420^{a}	1422^{a}	1421^{a}	291^{b}	293^{b}	292^{b}	<.0001
Chicken sale cost/Eth.br	2900^{a}	2426^{a}	2268^{a}	171^{b}	132^{b}	126^{b}	<.0001
Total return/Eth.br	1971^{a}	1497^{a}	1339^{a}	111^{b}	72^{b}	66^{b}	=0.03
Net return/Eth.br	551	75	-82	-180	-221	-226	=0.1

1=educated household group, 2=experienced household group and 3=neither educated nor experienced household group; Similar letters are indicated the there is no significant difference.

3.3 Economic Feasibility of Hay Box

The results of the relative economic feasibility of raising Sasso and Indigenous chicks with the use of hay box brooder in two production season are presented in Tables 3 and 4. The purchasing price of chicks, health cost, hay box brooder and running box construction cost to Sasso breed and indigenous chickens was the major variable cost during the experiment. In the first production season Sasso breed under educated farmer's groups were significantly (p<0.001) feasible than the others groups and all

Table 4. Economic feasibility of hay box for chicken production at second production time

Parameter	Sasso breed			Indigenous breed			p-value
	1	2	3	1	2	3	
Running box cost/Eth.br	20	20	20	10	10	10	=.0.1
Brooder cost /Eth.br	10	10	10	5	5	5	=0.1
Chicks purchasing cost	929[a]	929[a]	929[a]	60[b]	60[b]	60[b]	<.0001
Vaccination cost	1.01	3.03	2.02	1.1	3.04	2.1	=0.06
Total variable cost/Eth.br	960[a]	962[a]	961[a]	76[b]	78[b]	77[b]	<.0001
Chicken sale cost/Eth.br	2900[a]	2426[a]	2268[a]	171[b]	132[b]	126[b]	<.0001
Total return/Eth.br	1971[a]	1497[a]	1339[a]	111[b]	72[b]	66[b]	=0.03
Net return/Eth.br	1011[a]	535[b]	378[c]	35[d]	-6[e]	-11[e]	<0.01

1=educated household group, 2=experienced household group and 3=neither educated nor experienced household group; Similar letters are indicated the there is no significant difference

farmer's group that reared indigenous breed. But in the second production season, the hay box and running box maintenance cost, chicks cost and health cost was consider as presented in Table 4. The result indicated that, using of hay box brooder for chicken rearing under second production season was better profitable than first production season in rural area of South Gondar Zone.

Indigenous breed reared under hay box brooder was not economically feasible for this study but profitable for Sasso breed under good management handling [21-23].

4. CONCLUSIONS

The mean survival rate of baby chicks reared under natural brooding condition in Ethiopia is about 40% at 3-months age. About 85% of Sasso breed of chicks was survive at age of 8 weeks under hay box brooder, which indicating that this brooding technology is effective in rising exotic baby chicks under rural Ethiopian conditions. Unfortunately, the survival rate of indigenous chicks assigned to the hay box brooder was comparable to that of natural brooding. Therefore, it seems that the hay box chick brooding technology is not adequately effective in raising indigenous chicks as measured by chick growth performance and rate of survival to an age of 8 weeks. Hay box brooder was economically feasible for Sasso breed in all farmer groups under good handling management of the chicken. But in the case of indigenous breeds using of brooder box was not feasible unless using a large number of birds at a time. Further investigation into the determinant factors of indigenous chick's behavioral variability under different production systems seems to be the area of future research (among others). After week seven the space of running box for Sasso breed was not enough and need to modification for dual purpose chicken for the feature.

SUPPLEMENTARY MATERIALS

Supplementary material is available in the following link:

https://mbimph.com/index.php/UPJOZ/libraryFiles/downloadPublic/18.

ETHICAL APPROVAL

The experimental procedure was reviewed and approved by Debre Tabor University Research Ethics Committee (Ref. No. DTU10/20) and it was conducted by qualified and experienced personnel under the supervision of a veterinarian, according to the guidelines of the World Organization for Animal Health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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