Innovative Indigenous Brooding Strategies for Philippine Native Chickens: Effects of Local Alternative Heat Sources and Litter Floor Types on Productivity and Welfare

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ABSTRACT

Native chicken production offers a promising source of income for rural communities, especially in remote areas. However, natural brooding limits egg production per hen, making artificial brooding necessary. In mountainous regions without electricity, artificial brooding poses challenges. This study aimed to evaluate indigenous brooding strategies for Philippine native chickens, focusing on environmental conditions, growth performance, survival rate, and chick welfare.

A split-plot experiment using 252 chicks was conducted under a Randomized Complete Block Design (RCBD). The main factor was heating source—*Tukong*, Adjustable Hanging Heated Charcoal (AHHC), and Kerosene Lamp—tested across three litter floor types: White Wood Shavings, Rice Straw, and Rice Hull. AHHC consistently produced the highest temperature, lowest humidity ($p<.01$), and lowest litter moisture content ($p<.01$). AHHC with White Wood Shavings yielded optimal feeding, highest weight gain, and best feed conversion. This combination also showed the highest survival rate and thermal comfort, with no signs of huddling or panting. Mild hock burns and minimal breast and leg soiling were observed. Overall, chick viability post-brooding was highest under AHHC with White Wood Shavings, resulting in the best return on investment (ROI).

Keywords: indigenous heating contrivance, ambient, quality of life, thermal comfort

INTRODUCTION

A. Rationale

Native chicken production in the Philippines has been recognized by agricultural researchers and practitioners as a valuable economic activity in rural areas. It supports small-scale backyard farmers by offering a sustainable and equitable source of income. More than just a mono-commodity enterprise, native chicken raising is deeply integrated into diverse farming systems across the Philippines, contributing to both livelihood and food security.

To strengthen the Philippine organic native chicken industry, continuous improvement in management practices is essential—particularly in breeding, brooding, hardening, and growing. This study focuses on brooding strategies that are suitable for rural communities and adaptable to current environmental conditions. Brooding involves providing heat to chicks until they can regulate their body temperature. It can be done naturally, using a broody hen, or artificially, which allows for larger-scale chick production without relying on hens to brood.

Artificial brooding requires careful attention to factors such as litter management, heat sources, and bedding materials. Maintaining dry litter, along with proper temperature, feed, and water, is crucial for chick health [1]. Common bedding options include ground corncobs, chopped straw, wood shavings, and sawdust [2]. This study explores indigenous, economical heating materials for artificial brooding in the Philippine context, aiming to develop an organic brooding technology that supports chick welfare and is especially useful during colder months.

B. Objectives

The study aims to determine the best climate-smart indigenous brooding method for non-descript Philippine native chicken (combination of heat source and litter floor) during cold months in the country and to determine the following:

1. Temperature and relative humidity (RH) inside the brooder;

2. moisture content of the litter (bedding) as it is used;

3. level of ammonia (NH_3) in each brooding pen;

4. litter (bedding) quality score;

5. growth performance and survivability of the chicks in preparation to hardening in terms of: final weight, gain in weight, average gain in weight, average daily gain, feed consumption, water consumption, feed conversion ratio and mortality rate;

6. the physiological, health and behavioral adaptations of the birds to the indigenous brooding method;

9. the net profit factors (Cost and Return Analysis).

MATERIALS AND METHODS

A. The Locale of the Study

The study was conducted in the hilly area near the small ruminant project inside the Pampanga State Agricultural University (PSAU) campus located at PAC, San Agustin, Magalang Pampanga.

B. Experimental Animals

A total of 252 newly-hatched, healthy and active native chicks (126 male and 126 female) with an average weight of not less than 23.0 grams was used as experimental animals for comparison. The sex of the chicks was determined through vent sexing. These non-descript chicks was derived from the stocks of unknown origin which are commonly found in the backyard of the Filipino households. These were sourced out from different barrios where native chickens are available.

C. Experimental Treatments

Factor A - Source of Heat

H1 = Rice hull placed in *tukong* (holed 16 liters capacity oil can fill with sand) - This is a practice of brooding broiler chicks in Arayat, Pampanga.

H2 = Adjustable hanging heated charcoal **-** This is a method used by some gamefowl breeders in Mindanao.

H3 = Kerosene lamps **-** These are commonly used to provide supplementary heat to the chicks in areas where electricity is not available.

Factor B **-** Litter Floor

F1 = Wood shavings - These are medium-sized wooden particles preferred which cannot be eaten by the chicks.

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F2 = Shredded rice hay **-** This is available in most rural areas and easy to source out.

F3 = Rice hull **-** This is a widely used litter material available at a competitive price.

Figure 1. The different heat source from left to right: H1, H2 and H3

Figure 2. The different litter floor type from left to right: F1, F2, and F3

D. Experimental Design and Treatment Combinations

A two-factor split-plot experiment in Randomized Complete Block Design (RCBD) was used in the study. There were nine treatment combinations, replicated four times as follows:

H1F1	H2F1	H3F1
H1F2	H3F2	H2F2
H1F3	H2F3	H3F3

E. Experimental Lay-out

H3F1	**H2F3**	**H1F2**
H3F2	**H2F2**	**H1F3**
H3F3	**H2F1**	**H1F1**

BLOCK 1

H3F3	**H1F1**	**H2F2**
H3F1	**H1F2**	**H2F1**

H3F2	**H1F3**	**H2F3**

BLOCK 2

H2F1	**H3F2**	**H1F2**
H2F3	**H3F1**	**H1F3**
H2F2	**H3F3**	**H1F1**

BLOCK 3

H1F2	**H2F2**	**H3F1**
H1F3	**H2F3**	**H3F2**
H1F1	**H2F1**	**H3F3**

BLOCK 4

Number of treatment combinations --------------9

Number of replications ---------------------------- 4

Number of experimental birds per replication--7 heads

Total number of experimental birds ----------252 heads

Number of experimental pens ------------------36 units

Size of each experimental pen--------------------3 ft^2

Blocking factor-----direction of sun path (east to west)

F. Management Practices

1) Housing:

Thirty- six scratch pens with the base measuring one square meter (1 m^2) and height of 75 centimeters was purchased. These are already available in the market. These addressed the floor space requirement for the chicks which should not be less than .30 square feet (.30ft^2) per bird. Each pen contained seven chicks. The net was placed in all sides of the pens to avoid chicks from escaping and to prevent predators from entering the pen.

2) Gathering and Sterilization of Litter Floor Media to be Used:

Wood shavings, rice hull and shredded rice hay, was gathered and was sterilized to make sure that these are free from microorganisms and molds, which may cause harm to the digestive tract of the chicks.

3) Brooding Preparation:

The experimental perimeter was disinfected thoroughly, and the side of the pens was covered with curtains made from dry and disinfected sacks. The sources of heat were placed in every pen 30 minutes before expected day-old chick placement. The different litter materials (beddings) were placed in the corresponding pens. Old but clean newspaper was placed on the top of the beddings on the first day to allow the chicks to familiarize themselves to the feeds.

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4) Weighing and Grouping of the Birds:

The chicks were weighed and grouped accordingly. For every replication, there were 7 chicks placed which is composed of four males and three females. The average weight of the chicks used was not less than 23 grams. This is the standard weight of day-old native chicks under intensive management [4]. The gradient for blocking is the orientation of the experimental area, and it will be from east to west direction - from where the sun rises and to it sets.

5) Feeds and Feeding:

The feed given is chick booster crumble with not less than 21 per cent crude protein (CP) content. Feeding was done frequently with the right amount to minimize feed wastage. After 12 hours until the second day, when the chicks are already familiarized with the feeds, plastic chick feeder was gradually introduced to replace newspaper matting used as feeders. Feed refusal was measured before replacing the feeder with fresh feeds. Through this, feed consumption of the birds was measured.

6) Provision of Drinking Water:

Before the arrival of the chicks, the drinkers were prepared. Clean water was mixed with 5% brown sugar. The sugar in water given to the chicks during the first four hours served as an immediate source of energy. One jar - type chick-sized drinker, was placed in each pen. Clean and potable water was provided to the chicks at all times. Water consumption was determined using the amount of water refusal measured before the replacement of new and clean water.

7) Health Program:

Garlic was added to the drinking water after three days, to aid in disease prevention. Garlic as natural antibiotic was given for five consecutive days. Three to four cloves were added to every jar-type chick-sized drinker. This was repeated in the second week for the prevention of immuno-suppressive diseases. The chicks were vaccinated with NCD B1B1 through intraocular and intranasal at seven days of age. This is to prevent New Castle Disease (NCD) or avian pest. The second dose of vaccination was at four weeks of age at the termination of the study using NCD *La Sota*, a live vaccine.

8) Heater Management:

The optimum brooding temperature was maintained. The temperature supplied by the different heat sources was noted, and proper adjustments was done. The behavioral reactions of the chicks were used as a guide in heater management. Brooder temperatures were measured about 3 inches (7.6 cm) off the floor and about 3 inches (7.6 cm) from the inner edge of the pen as well as the relative humidity (RH). The kerosene lamp and *tukong* was placed just above ground. The hanging charcoal was hung and adjusted accordingly.

9) Litter Management:

The thickness of the litter was maintained at not less than five centimeters. It was checked and mixed daily to prevent caking. The floor was added with bedding materials every five days after litter quality scoring and measuring its moisture content. The thickness of the materials added was 5 centimeters. The moisture of the bedding was measured using the litter moisture sensor meter. The sensor was pointed closely to the beddings, and the moisture percentage was recorded.

The level of ammonia (NH_3) was measured using ammonia meter at the same spot where the temperature and humidity was gathered.

10) Sanitation Practices:

Feeders and d rinkers were washed daily using dishwashing soap. These were dried thoroughly before the loading of fresh feeds and clean water. Used litter materials was removed and disposed of properly after the brooding period.

11) Data Gathering:

The data gathered was the following:

1. The Temperature inside the brooding pen - Thermometer was used in measuring daily temperature. Measuring of temperature was done regularly - day and night alternately. The temperature was also taken as the panting or huddling was observed.

2. Percentage Relative Humidity (% RH) - This was measured using hygrometer and was recorded simultaneously as the temperature was measured.

3. Moisture Content of the litter (bedding) as it is used - This was measured using moisture sensor meter every five days.

4. Ammonia (NH_3) level - Ammonia level was measured using ammonia meter simultaneously with the measurement of moisture.

5. Litter quality score - The litter was scored according to a 5 points scale where a score of 1 means that the litter is dry and flaky, and a score of 5 means that the litter is wet and capped (*Adapted from* European Welfare Quality® 2009)[3]. Scoring was done every five days.

6. Growth Performance:

a. *Initial Weight* - This was gathered at the start of the study.

b. *Final Weight* - This was gathered in the termination of the study.

c. *Average Gain in Weight* - Average Initial weight was subtracted from the average final weight.

d. *Average Daily Gain (ADG)* - Gain in weight divided by the number of rearing days (throughout the period of the study).

e. *Total Feed Consumption* - The total feeds refusal in each experimental treatment was subtracted from the total amount of feeds offered.

f. *Total Water Consumption* - The total amount of water refusal in each experimental treatment was subtracted from the total amount of water offered.

g. *Feed conversion ratio (FCR)* - Total feed consumed per bird was divided by the average gain in weight.

7. Mortality Rate - the number of dead birds was recorded on per treatment basis, and the percentage mortality was computed for comparison. The formula was:

% Mortality = Number of dead birds per treatment ÷ Starting number of birds reared per brooding treatment x 100

8. Physiological, Health and Behavioral Adaptation of the Birds - The bird quality of life was assessed using European Welfare Quality® assessment protocol on the selected animal-based parameters.[3]

The following are the parameters and measurements:

a. *Thermal comfort* - Panting (too hot) and Huddling (too cold)

Observations were done every other day, starting from Week 1 in every pen throughout the study. This was

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done between 10:00 a.m. and 3:00 p.m. and between 10:00 p.m and 3:00 a.m. The proportion of birds showing panting or huddling was estimated and scored into five classes: 0 = none, 1= a few, 2 = a half, 3 = more than a half, and 4 = all birds are showing panting/huddling behavior.

b. *Plumage cleanliness* **-** individual sample chicks was picked up, and plumage cleanliness (feather soiling) was observed. Clean or no soiling of feathers is equivalent to 0, mild soiling of the breast and legs is equivalent to 1 and severe soiling of the breast, legs and wings is equivalent to 2. It was done in the third week of brooding.

c. *Hock burn, footpad dermatitis and breast blister* **-** No lesions are equal to 0, mild evidence of burn/lesion is equal to 1, and severe burns/lesions is equal to 2. This was done simultaneously with the observation on plumage condition.

9. Cost and Return Analysis -The net income was computed by subtracting the total cost of production of every treatment combination to the gross income.

The return on investment was computed using this formula:

% ROI = Net Income ÷ Total Cost of Production x 100

12) Statistical Treatment of Data:

The data gathered was subjected to statistical analysis. The data on the environmental conditions, growth parameters, and mortality rate was subjected to Analysis of Variance (ANOVA). Litter condition score was subjected to Kruskal Wallis sum test and Plumage cleanliness score and hock burn, footpad dermatitis and breast blister score was subjected to descriptive analysis.

RESULTS AND DISCUSSION

A. Temperature Inside the Brooding Pen

The warmest temperature produced was from the interaction between H2 and F1 followed by F2 and F3 under the same heat source which is adjustable hanging heated charcoal (AHHC). Meanwhile, the coolest temperature was recorded in the interaction between H1 and F2. Among the heat sources, AHHC produced the highest temperature which is significantly different from the other heat source group. In addition, the main effect of producing warmest temperature to the heat sources from the levels of litter floor is the white wood shavings (Table I).

The temperature among the treatment was within the ambient temperature requirement for brooding which is 31℃ ± 1℃ [4]. However, it was observed that when the temperature was < 31℃ the birds are starting to huddle. No panting observed.

B. Relative Humidity (RH)

The interaction between *tukong* (H1) and rice hay (F2) resulted to highest humidity percentage. This was followed by the interaction of kerosene lamp (H3) and Rice hay.

However, the lowest RH recorded was under the AHHC (H2) litter floor groups, thus it is the main effect of producing minimal relative humidity among all litter floor types (Table I).

It was observed that when the humidity went higher than 75%, the birds are huddling. Moreover, the RH lower than 70% during this brooding period is even better. In this study, AHHC resulted to the minimal dampness in the brooder within all levels of litter floor. The litter on dirt floor presented 8-10% less humidity and lower fermentation[5]. It prevents huddling among the chicks.

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C. Moisture Content and Ammonia (NH_3) Levels

The highest moisture content recorded was from the interaction between H1 and F3 and the interaction of H3 and F2 while the interaction between F1 the two heat source group (H2 and H3) gave the lowest moisture content percentage (Table I). The moisture content recorded in the study is very low. This low moisture produced among the beddings used in the experiment is attributable to good litter floor management.

Because of this moisture level, it is impossible for the ammonia to proliferate. There is no ammonia produce in the experimental pen since the moisture did not even reach its threshold level. The optimum litter moisture content that can minimize odorant and dust release is somewhere within the range of 25 to 45%[6], and that 20-25% litter moisture is considered good[1], wherein ammonia is not usually produced [7].

Table I. Brooding Environment Parameter: Temperature, Humidity And Moisture Content Of The Litter

Exp. Treatment	**Parameter Mean**			**Factor (Sig. level)**
	Temperature (℃)	**Humidity (%)**	**Moisture Content (%)**	**(a) =H** **(b) =F** **(IA) = H x F**
H1F1	30.58^{abc}_{x}	77.82^{abc}_{y}	5.00^{ab}_{y}	IA**(for Temp. and Humid); IA*(for MC)
H1F2	30.42^{abc}_{z}	78.08^{a}_{x}	5.00^{ab}_{y}	IA**(for Temp. and Humid); IA*(for MC)
H1F3	30.54^{abc}_{y}	77.69^{a}_{z}	6.25^{a}_{x}	IA**(for Temp. and Humid); IA*(for MC)
H2F1	32.58^{a}_{x}	70.40^{bc}_{y}	2.50^{b}_{y}	IA**(for Temp. and Humid); IA*(for MC)
H2F2	32.54^{ab}_{y}	70.31^{bc}_{z}	3.75^{ab}_{x}	IA**(for Temp. and Humid); IA*(for MC)
H2F3	32.20^{ab}_{z}	71.83^{bc}_{x}	3.75^{ab}_{x}	IA**(for Temp. and Humid); IA*(for MC)
H3F1	30.63^{abc}_{x}	77.38^{bc}_{z}	2.50^{b}_{z}	IA**(for Temp. and Humid); IA*(for MC)
H3F2	30.47^{bc}_{y}	78.06^{ab}_{x}	6.25^{a}_{x}	IA**(for Temp. and Humid); IA*(for MC)
H3F3	30.47^{bc}_{y}	77.76^{ab}_{y}	3.75^{ab}_{y}	IA**(for Temp. and Humid); IA*(for MC)
CV (%): (a)	0.07	0.14	37.06	-
(b)	0.10	0.14	24.99	-

Means with the same letter are not significantly different **p<0.01; *p<0.05

IA - Interaction

Superscript = Comparison across all treatments

Subscript = Comparison of the litter floor (F) in each source of heat (H)

D. Litter Condition Score

In terms of litter condition score, no significant differences were observed among the treatments as their replicates are having the score that are not significantly different. From the scale of 5 wherein 1 is dry and flaky and 5 is wet and capped, the average scores of the replications per treatment is ranging from 1-3 (Table II).

The description on litter condition is in between dry and flaky and wet and capped. This is an attribute of good litter floor management regardless of the type of bedding materials used. Effective litter management—including moisture control, routine raking, and proper ventilation and drinker placement—is essential across bedding types such as paddy husk, wood shavings, and sawdust [8]

Table Ii. Litter Condition Mean Score

TREATMENT	**BLOCK**				**Mean Score^{ns}**
	1	**2**	**3**	**4**	
H1F1	2.00	2.00	2.00	2.00	2.00
H1F2	1.25	2.25	2.25	1.75	1.88
H1F3	2.00	2.00	2.00	2.00	2.00
H2F1	1.00	1.00	1.00	1.00	1.00
H2F2	1.00	1.00	1.00	1.75	1.19
H2F3	1.00	1.00	1.00	1.00	1.00
H3F1	1.50	1.50	1.50	1.50	1.50
H3F2	1.00	3.00	3.00	3.00	2.50
H3F3	2.00	1.75	1.75	1.75	1.81

Result from Kruskal-Wallis's rank sum test: Chi-

Square 1.3605 DF 3

Pr > Chi-Square 0.7148 ^{ns}Not Significant

E. Growth Performance and Mortality Rate

The main effect of adjustable hanging heated charcoal (H2) in all level of litter floor groups, resulted to higher final weight where white wood shavings (F1) is the highest. This is similar to the effect of F1 in all level of heat sources. Meanwhile, the lowest final weight recorded in every heat source is the effect of rice hull (Table III).

The low final weight in F3 is because the birds are feeding on rice hull which makes them unable to feed the right amount of feeds. The rice hull served as filler food but is not giving nutrients for growth.

The high final weight in H2 is the product of ambient temperature and lower relative humidity that did not cause huddling enabling the birds to feed more frequent. The heat stress due to high temperature and humidity results in poor feed intake among the chicks[9].

As to gain in weight among the birds, the main effect of AHHC (H2) in all level of litter floor groups, resulted to higher average gain in weight where white wood shavings (F1) is the highest. This is similar to the effect of F1 in all level of heat sources. Meanwhile, the lowest AGW recorded in every heat source is the effect of rice hull (F3).

The gain in weight of the birds is significantly different among the three litter floor types wherein white wood shavings is the highest, seconded by rice straw, and then rice hull (Table III).

In terms of average daily gain among the birds, the main effect of AHHC (H2) in all level of litter floor groups, resulted to higher average daily gain where white wood shavings (F1) gave the highest. This is similar to the effect of F1 in all level of heat sources. Meanwhile, the lowest ADG recorded in every heat source is the effect of rice hull (F3).

The ADG of the birds is significantly different among the three litter floor types wherein white wood shavings is the highest, seconded by rice straw, and then rice hull (Table III). Colored bedding such as rice hull, and other by-products obtained from the feed mill could make the brooder house darker thus, there will be extra lightings needed to provide accessibility to the feeds [1]

Table Iii. Growth Performance Parameters: Final Weight, Average Gain In Weight, Average Daily Gain

Exp. Treatment	**Parameter Mean**			**Factor (Sig. level)**
	Final Wt. (grams)	**Ave. Gain in Wt. (grams)**	**Ave. Daily Gain (grams)**	**(a) =H** **(b) =F** **(IA) = H x F**
H1F1	82.53^{ab}_{x}	58.72^{abc}_{x}	2.10^{abc}_{x}	IA**(all parameters)
H1F2	77.76^{b}_{y}	53.96^{bc}_{y}	1.93^{bc}_{y}	IA**(all parameters)
H1F3	64.31^{bc}_{z}	40.51^{c}_{z}	1.45^{c}_{z}	IA**(all parameters)
H2F1	127.23^{a}_{x}	103.45^{a}_{x}	3.70^{a}_{x}	IA**(all parameters)
H2F2	124.11^{ab}_{y}	100.29^{ab}_{y}	3.58^{ab}_{y}	IA**(all parameters)
H2F3	73.92^{b}_{z}	50.12^{b}_{z}	1.79^{b}_{z}	IA**(all parameters)
H3F1	84.04^{ab}_{x}	60.26^{ab}_{x}	2.15^{ab}_{x}	IA**(all parameters)
H3F2	78.66^{b}_{y}	54.85^{b}_{y}	1.96^{b}_{y}	IA**(all parameters)
H3F3	67.82^{bc}_{z}	44.03^{bc}_{z}	1.58^{bc}_{z}	IA**(all parameters)
CV (%): (a)	1.37	1.77	1.72	-
(b)	1.48	2.10	2.07	-

Means with the same letter are not significantly different **p<0.01

IA - Interaction

Superscript = Comparison across all treatments

Subscript = Comparison of the litter floor (F) in each source of heat (H)

The interaction of AHHC (H2) and white wood shavings (F1), resulted to highest feed intake seconded by the interaction of kerosene Lamp (H3) and WWS (F1). WWS also gave the highest feed intake among litter floor groups under *tukong* (H1). However, among the heat sources, H1 resulted to lowest feed consumption of the birds which is significantly different with H2 and H3 (Table IV).

The use of AHHC resulted to highest feed intake in white wood shavings and rice straw. This due to ambient temperature and right relative humidity provided by the interaction (Bock). Kerosene lamp also has the same result from all litter floor groups. This is because the birds can feed during night time since it is illuminating the pen. The birds can feed well as long as the temperature and humidity are right, because these prevent them from huddling[5] [9]. However, among the litter floor groups rice hull caused the least feed intake. This is because the birds are feeding on rice hull which is a fibrous material as it was observed. Portion of the birds' feed intake was the rice hull instead of feeding on a complete ration. A particular litter floor type has its property that could directly influence the performance of the chicks in terms of feeding and growth response [1].

The interaction between *tukong* (H1) and rice hull (F3) resulted to highest water consumed followed by the interaction of kerosene lamp **(**H3) and WWS (F1). The higher water intake is an attribute of the continuous light provided by the kerosene lamp allowing the chicks access water even at night time. Meanwhile, the lowest water consumed was in H1F1 seconded by H2F2. However, there is no significant difference among heat sources in all level of litter floor.

White wood shaving (F1) is the main effect of having the efficient feed conversion ratio across all the heat sources, having that of AHHC (H2) as the best. Meanwhile the least efficient FCR was of that in H3F3 seconded by H1F3. This signifies that the poorest FCR in all levels of heat sources was under rice hull (F3). Meanwhile, the high feed intake in H3 is the result of the light produce by the kerosene which allows the bird to feed even at night time (Table IV).

Based the data gathered, feeding in night time did not signifies the increase in weight, and in addition, this is not a good sign of animal welfare since the birds could not rest well. The FCR from AHHC is an indicator that it is possible to reach one-kilogram weight as early as 12 weeks under improved management [10].

The lowest mortality rate is from H2F1 in all levels of litter floor followed by H2F2. The highest mortality rate is from H3F3 followed by H3F2 (Table IV).

Numerically, the lowest mortality rate recorded was from white wood shavings (F1) in AHHC (H2). It means that under harsh condition, H2F1 can give high survival rate among the chicks. H2F1 was tested and proven the best among other treatments on harsh environmental condition including cold, humid and rainy days occurred in the duration of the study.

It is an attribute of the AHHC's position in the pen which is easy to be adjusted and reloaded with charcoal since it is hanging. Besides, white wood shavings is also an excellent bedding material that cannot be eaten by the chicks. This is the difference between WWS and rice hull. Feeding on rice hull causes digestion problem on baby chicks which resulted to stunted growth and highest mortality rate. One concern that should not be overlooked for a productive poultry farming is the quality of litter alongside quality of chicks, feed and water [11].

Table Iv. Feed Consumption, Water Consumption, Feed Conversion Ration, And Mortality Rate

Exp. Treatment	**Parameter Mean**			
	Feed Consumed (grams)	**Water Consumed (ml)**	**Feed Conversion Ratio (FCR)**	**Mortality Rate (%)**
H1F1	913.06^{abc}_{x}	2134.54^{ab}_{z}	4.50^{ab}_{z}	50.01^{b}_{y}
H1F2	894.56^{bc}_{y}	2142.10^{ab}_{y}	4.81^{ab}_{y}	50.01^{b}_{y}

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H1F3	847.00^{b}_{z}	2476.40^{a}_{x}	7.49^{ab}_{x}	57.15^{ab}_{x}
H2F1	1156.67^{a}_{x}	2287.05^{ab}_{x}	2.24^{bc}_{z}	17.86^{bc}_{z}
H2F2	1110.00^{ab}_{y}	2188.11^{ab}_{z}	2.48^{bc}_{y}	32.16^{bc}_{y}
H2F3	918.15^{b}_{z}	2224.24^{a}_{y}	5.32^{ab}_{x}	50.01^{b}_{x}
H3F1	1114.64^{a}_{x}	2361.70^{a}_{x}	4.99^{ab}_{z}	46.45^{b}_{z}
H3F2	1076.36^{ab}_{y}	2277.62^{ab}_{y}	6.12^{ab}_{y}	53.58^{ab}_{y}
H3F3	983.14^{b}_{z}	2215.51^{ab}_{z}	11.18^{a}_{x}	78.57^{a}_{x}
Factor (Sig. level)				
(a) =H **(b) =F** **(IA) = H x F**	IA**	IA*	IA*	a**;b**;IA^{ns}
CV (%): (a)	3.89	5.58	16.05	13.90
(b)	3.85	5.74	19.04	18.82

Means with the same letter are not significantly different **p<0.01; *p<0.05; ^{ns}Not Significant

IA - Interaction

Superscript = Comparison across all treatments

Subscript = Comparison of the litter floor (F) in each source of heat (H)

F. Physiological, Health and Behavioral Adaptation of the Birds

1) Thermal Comfort (Panting and Huddling)

Halves of the birds in H1F1 with its litter floor levels are showing panting as well as the H3 with its litter floor levels. Meanwhile, no huddling occurs in H2F1 and H2F3 and there are few birds showing huddling in H2F2. Therefore, thermal comfort is achievable in H2F2 as well as in H2F3. Comfortable ambient temperature ensures proper physiological development and welfare[12].

Table V. Huddling Mean Score And Score Description

TREATMENT	Mean Score	Score Description
H1F1	2	A half showing huddling
H1F2	2	A half showing huddling
H1F3	2	A half showing huddling
H2F1	0	none
H2F2	1	A few showing huddling

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H2F3	0	none
H3F1	2	A half showing huddling
H3F2	2	A half showing huddling
H3F3	2	A half showing huddling

Mean score was derived from the Descriptive Analysis in Statistical Tool for Agricultural Research (STAR)

2) Plumage Cleanliness

The highest percentage of having severe soiling of breast legs and wings was H3F3 and H1F3. Meanwhile, H2F1 has the highest percentage of chicks that are clean or without soiling. The rest of the sample experimental birds are having mild soiling of breast and legs

Table Vi. Plumage Cleanliness Description Table

TREATMENT	Score	% out of 12*	Description
H1F1	0	0	Clean or no soiling
	1	100	Mild soiling of breast and legs
	2	0	Severe soiling of breast, legs and wings
H1F2	0	0	Clean or no soiling
	1	91.67	Mild soiling of breast and legs
	2	8.33	Severe soiling of breast, legs and wings
H1F3	0	0	Clean or no soiling
	1	41.67	Mild soiling of breast and legs
	2	58.33	Severe soiling of breast, legs and wings
H2F1	0	83.33	Clean or no soiling
	1	16.67	Mild soiling of breast and legs
	2	0	Severe soiling of breast, legs and wings
H2F2	0	75	Clean or no soiling
	1	25	Mild soiling of breast and legs
	2	0	Severe soiling of breast, legs and wings
H2F3	0	41.67	Clean or no soiling
	1	58.33	Mild soiling of breast and legs
	2	0	Severe soiling of breast, legs and wings

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H3F1	0	0	Clean or no soiling
	1	67	Mild soiling of breast and legs
	2	33	Severe soiling of breast, legs and wings
H3F2	0	0	Clean or no soiling
	1	75	Mild soiling of breast and legs
	2	25	Severe soiling of breast, legs and wings
H3F3	0	0	Clean or no soiling
	1	16.67	Mild soiling of breast and legs
	2	83.33	Severe soiling of breast, legs and wings

*3 samples per replicates (4) = 12

3) Hock burn, Footpad Dermatitis and Breast Blister

Majority of the birds got no lesions among all treatment combination. Very low percentage of birds from H1F1, H1F3, H2F1, H3F1 and H3F3 are having mild evidence of burn/lesions. Good litter condition prevents the incidence of footpad dermatitis [7]

Table Vii.

TREATMENT	**Score**	**% out of 12***	**Description**
H1F1	0	91.67	No Lesions
	1	8.33	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
H1F2	0	100	No Lesions
	1	0	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
H1F3	0	91.67	No Lesions
	1	8.33	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
H2F1	0	91.67	No Lesions
	1	8.33	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
	0	100	No Lesions

H2F2	1	0	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
	0	100	No Lesions
H2F3	1	0	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
	0	91.67	No Lesions
H3F1	1	8.33	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
	0	100	No Lesions
H3F2	1	0	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions
	0	91.67	No Lesions
H3F3	1	8.33	Mild Evidence of Burn/Lesions
	2	0	Severe Burn/Lesions

Hock Burn, Footpad Dermatitis And Breast Blister Descriptive Table

*3 samples per replicates (4) = 12

G. Cost and Return Analysis

The highest ROI was from H2F1. The result of the analysis shows that every peso of investment can get double when using AHHC and White Wood Shavings. Though the cost of charcoal is higher than Kerosene and all the other expenses are the same to all treatment combinations, H2F1 signifies the highest income. This high income was derived from the viable birds after the brooding period. The highest number of viable birds was from the combination of H2 and F1. It was seconded by AHHC and Rice Hay. The lowest return was from the litter floor combined with Kerosene. This is the result of lower survival rate during the brooding period (Table VIII).

Table Viii. Cost And Return Analysis

Operating Expenses	**H1F1**	**H1F2**	**H1F3**	**H2F1**	**H2F2**	**H2F3**	**H3F1**	**H3F2**	**H3F3**
Stocks (Chicks)	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00	350.00
Feeds (Chick Booster)	64.00	64.00	64.00	64.00	64.00	64.00	64.00	64.00	64.00
Vaccine (B1B1/LaSota)	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11	31.11
Garlic	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Vinegar	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Kerosene	-	-	-	-	-	-	104.00	104.00	104.00
Charcoal	90.00	90.00	90.00	150.00	150.00	150.00	-	-	-
Rice hull	50.00	50.00	70.00	-	-	20.00	-	-	20.00
Wood Shavings	10.00	-	-	10.00	-	-	10.00	-	-
Rice straw	-	10.00	-	-	10.00		-	10.00	-
Labor cost	888.89	888.89	888.89	888.89	888.89	888.89	888.89	888.89	888.89
Depreciation cost									
Scratch pens	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Feeder	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
Waterer	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Sacks	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tukong	2.00	2.00	2.00	-	-	-	-	-	-
TCP (OE +LC +DC)	1,640.0	1,640.0	1,651.0	1,649.0	1,649.0	1,659.0	1,603.0	1,603.0	1,613.0
Gross Income									
Sales from one month old chicks	2,100.0	2,100.0	1,800.0	3,450.0	2,850.0	2,100.0	1,950.0	2,250.0	900.0
Net Income	460.00	460.00	150.00	1,801.0	1,201.0	441.00	347.00	647.00	-713
ROI%	28.05	28.05	9.90	109.22	72.83	26.58	21.65	40.36	-44.20

CONCLUSION

The use of adjustable hanging heated charcoal (AHHC) with the white wood shavings (WWS) is a good strategy of artificial brooding on non-descript Philippine native chicken. These two complemented to provide the ambient temperature and relative humidity that resulted in frequent feeding to increase weight gain and convert feed efficiently to gain more profit.

More so, animal welfare which was measured by the animal-based parameters is not sacrifice.

The author, based on the result obtained would like to recommend the following:

1. the use of adjustable hanging heated charcoal (AHHC) and white wood shavings in artificial brooding in the remote rural area where electricity is scarce.

2. test AHHC and WWS during summer brooding.

3. test AHHC and WWS to standard breed of free-range chicken.

4. correlate the data on temperature versus gain in weight and humidity versus gain in weight.

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