Nutritional Evaluation of Hydroponic Corn Fodder and its Effect as Substitute for Feed Concentrates for Buffalo Calves

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This study investigated the effects of hydroponic corn fodder on the growth performance of buffalo calves. Twelve Bulgarian Murrah buffalo calves were divided into two treatment groups: T1, fed with Napier grass and starter feed concentrates, and T2, fed with Napier grass, starter feed concentrates, and hydroponic corn fodder, replacing 50% of the starter feed concentrate. The study found no significant differences between the two groups' average total weight gain and average daily gain. However, the average daily feed intake was significantly higher in T2, possibly due to the tender and young nature of the hydroponic corn fodder. Dry matter and crude protein intake did not show any significant differences between the two groups. The digestibility of nutrients showed a significant difference in dry matter digestibility between T1 and T2. Feed cost per d was significantly lower in T1, but the cost of feed per kg gain was lower in T2. This study suggested that supplementing buffalo calves' diets with hydroponic corn fodder could have a beneficial effect on their growth performance and economic viability. It recommends further research on the use of other grains as fodder for ruminants. Overall, this study highlighted the potential of hydroponic corn production as a sustainable source of fodder for ruminants.

Keywords: buffalo, calves, corn fodder, hydroponics

INTRODUCTION

Several technologies have been developed to address poor animal nutrition and increase farmers’ income. However, despite these efforts, calf morbidity and mortality remain recurring problems due to factors such as insufficient milk feeding and calf injuries and diseases. Production and reproduction efficiencies are associated with farmers' managing and feeding their buffaloes. The productivity of animals is generally low due to poor nutrition, resulting in poor birth weight of the calf and occasional abortion. Calves eventually serve as the productive unit of the herd and need to be protected, managed, and fed properly for their population to grow economically at an optimum rate. The first 3 mo of age is the most critical for calves; hence, the feeds offered should contain 18% crude protein (CP) to achieve economical and optimum growth (Amaral-Phillips et al. 2006). Underfeeding significantly reduces growth rates to 50% during the rearing phase which may cause delayed puberty. To attain a daily weight gain of 450 – 500 g in buffalo calves, a concentrate mixture containing 20% CP and 63% total digestible nutrient (TDN) may be fed at 1.5 – 3.0 kg per head per day at 100 – 250 kg body weight or above along with 10 kg green fodder and ad libitum straw. When green fodder is unavailable, an additional 1 kg of concentrate mixture should be fed as a replacement for 10 kg of green fodder (Paul and Sunesh 2003).

Central Luzon was previously ranked as the region with the third highest population of carabaos at 264 290 heads (Del Prado 2023). Within the region is the province of Nueva Ecija, which is designated the National Impact Zone (NIZ) for water buffalo development; however, it faces a deficiency in forage, projected to be at 40% of the requirement (Palacpac et al. 2016). In this area, many smallholder farmers still practice the traditional method
of feeding their animals and are unfamiliar with methods such as forage crop cultivation. This can be attributed to several factors including the very small proportion of land area available for fodder development, the high cost of labor, and the insufficient supply of water (Naik et al. 2016). Farmers spend more time feeding their animals by tethering in distant areas or by cutting feed far from their homes. Consequently, many farmers must reduce their animal holdings or find new feed resources to maintain their animals’ health and nutritional requirements.

To support the nutritional requirements of buffaloes, hydroponics can be used as a source of fresh forage in fodder production. Hydroponic fodder production can also be an alternative solution to the limited land area allocated to forage production for ruminant raisers and to the limited water supply for irrigation since forages can be cultivated with only water and without the use of soil (Naimasia 2015). Moreover, there will be no need for long-term feed storage, no feed nutrient losses, low labor cost, and low cost of production for ruminant raisers (AgriFarming 2014). Hydroponics can also produce high-quality, nutritious green fodder from grain crops such as corn, wheat, barley, oats, and sorghum. Among these, corn is considered the most important grain used as livestock feed because it contains important minerals, vitamins, energy, protein, and digestible fiber for animal nutrition (Loy and Lundy 2019). In the Philippines, corn is the most planted grain crop, with Central Luzon producing about 8.5 MT or 0.4% of the country’s total corn production (PSA 2023).

Limited studies have been done on the effect of hydroponic fodder as feed for calves; therefore, this study was conducted to address the gap in poor nutrition due to the lack of quality forage and limited area for forage production as well as to enhance buffalo calf production and farmers’ income through the development and utilization of hydroponic corn. Specifically, this study aimed to: (1) evaluate the chemical composition of hydroponic corn fodder; (2) determine the effect of hydroponic corn fodder as a substitute for starter concentrates (50% reduction) on buffalo calf dry matter intake and performance; (3) determine the dry matter and crude protein nutrient digestibility of hydroponic corn fodder; and (4) measure the profitability of utilizing hydroponic corn fodder as a substitute for commercial feed concentrates in feeding buffalo calves.

**MATERIALS AND METHODS**

**Seed Selection and Preparation**

High-quality whole feed-grade yellow corn seeds (Pioneer 4097YHR) were acquired from IRC Silage Producer in Lupao, Nueva Ecija and were stored and sealed properly in a plastic container. Prior to germination, seeds were washed with water to remove the impurities and then soaked in 1 – 1.5% bleach solution for 2 h (Starova 2016), drained, and rinsed. Finally, the seeds were soaked in water overnight to obtain better seed growth and development.

**Seed Germination and Growth**

About 1 kg of pre-soaked seeds was spread uniformly with a thickness of 1.5 – 2 cm into sprouting plastic trays with a few holes at 1 side that served as drainage then covered with wet newspaper or damp cloth for 1 – 2 d (Fig. 1). Thereafter, the trays were placed in a fabricated housing structure consisting of 3 wooden racks/shelves measuring 500 x 53 x 168 cm to produce hydroponic fodder.

The wooden rack can accommodate 30 trays measuring 38 x 30 x 9 cm or a total of 90 trays in the entire setup with a seed density of 1 kg per tray (Fig. 2). During the growing period, the corn grains were kept moist by drip watering or by spraying tap water every 4 h and were allowed to sprout for 8 d and harvested as fodder for feeding the buffalo calves based on the result of laboratory analysis of hydroponic corn fodder (HCF) from days 0 – 9 (Fig. 3). Hydroponic corn fodder was grown daily, and the production process was repeated daily.

**Laboratory Analysis**

Before the feeding trial, an experiment was conducted to allow the corn seeds to sprout until day 9 and to determine if there were significant differences in the nutrient composition from days 0 – 9. The results of this...
trial served as the basis for sprouting HCF on day 8 for the feeding trial, in accordance with the observations mentioned by Naik et al. (2015) in his study related to hydroponic corn fodder.

Fresh hydroponic corn fodder samples (500 g) from days 1 – 9, including the soaked seeds overnight, were collected in 3 replicates and analyzed to determine the nutrient composition such as percent dry matter (% DM), ash (% Ash), protein (% CP), and ether extract (% EE) at different ages to establish the ideal age to harvest hydroponic corn fodder with optimum chemical composition following the standard procedures of AOAC (2006) for laboratory analysis. All the analyses were conducted at the Production System and Nutrition Section Laboratory of the Philippine Carabao Center National Headquarters and Gene Pool.

The data collected were analyzed using One-way Classification Analysis of Variance (ANOVA) to compare means among days of growing from 0 to 9 for each parameter (% DM, CP, Ash, and EE). Tukey’s HSD was used to test all pairwise differences. The sprouting days were considered as treatments. Furthermore, the chemical composition of HCF from days 0 – 9 underwent linear and quadratic trend analyses.

Experimental Animals, Design, and Treatments

This study was conducted at the PCC Gene Pool Farm, Science City of Muñoz, Nueva Ecija. A total of 12 newly weaned Bulgarian buffalo calves (6 male and 6 female) with an average weight of 88.17 + 4.19 for T1 and 88.17 + 5.23 kg for T2 and age of 3 mo were used in the feeding trial. Before the conduct of the experiment, the experimental animals were dewormed and injected with vitamins A, D, and E following the recommended dosages. After this, the animals were randomly assigned into 2 treatments with 6 replications per treatment. Each treatment group of newly weaned calves was fed 1 of the 2 rations following the Randomized Complete Block Design (RCBD) using the Paired difference two-sample t-test.

Preparation of Dietary Ration

Rashid et al. (2015) found that a feedlot ration containing Concentrate: Ratio (C:R) = 75:25 gives satisfactory weight gain at minimum risk, although the ratio can vary from 50:50 to 90:10. They also observed that feeding high forage at concentrations greater than 55% may reduce gain and feed conversion. In addition, they concluded that a diet consisting of C:R ratio 55:45 may be used for growing Brahman local crossbred calves in feedlot.

The Napier-based basal diet (T1) in this study contained 0% HCF + 48% starter feed concentrate (48:52 C:R ratio at dry matter [DM] basis) and the hydroponic corn-based diet (T2) contained 24% HCF + 24% starter feed concentrate (24:75 C:R ratio at DM basis), where 50% of the starter feed concentrate was supplemented with hydroponic corn fodder (Table 1) prepared (Fig. 4a and 4b) following the recommended rate and offered to the animals.
The calculated nutrient composition of the 2 dietary rations was shown in Table 2. The rations for both treatments were computed based on the DM, CP, TDN, Ca, and P requirements of growing calves with approximately 100 – 150 kg BW with 500 g average daily gain (ADG) (Kearl 1982; PCC 2009).

Feeding Management
All the experimental animals were housed and fed individually with the assigned feed ration throughout the 90 d feeding trial. Prior to the actual data collection, a 15 d adjustment period was considered for the animals to be accustomed to the new ration.

Initial and subsequent weights were recorded every 30 d before feeding in the morning to get the actual weight of the animals for the computation of ADG.

A total of 6 growing calves were used in each treatment group and were fed twice a day with the assigned rations in the morning and afternoon and provided with ad libitum water. The amount of feed offered and orts were recorded daily to calculate the total voluntary dry matter intake.

Nutrient Feed Intake
The feed and nutrient intakes were determined using the calculated difference between the feed offered and orts. DM requirements of the dairy buffaloes were based on the percentage of the animal’s body weight according to Kearl (1982) and Sarabia et al. (2009) (150 kg BW with 500g ADG requires 2.7% BW DM Intake).

<table>
<thead>
<tr>
<th>Feeds (As Fed basis)</th>
<th>T1- Control- 0% HCF + 48% Concentrate</th>
<th>T2- With HCF Supplementation 24% Concentrate + 24% HCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Napier, kg</td>
<td>9.55</td>
<td>9.55</td>
</tr>
<tr>
<td>Starter concentrate, kg</td>
<td>2.22</td>
<td>1.11</td>
</tr>
<tr>
<td>Hydroponic corn fodder, kg</td>
<td>0.00</td>
<td>5.56</td>
</tr>
<tr>
<td>Total, kg</td>
<td>11.77</td>
<td>16.22</td>
</tr>
</tbody>
</table>

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Dry Matter Intake (DMI)= (Feed Offered – Feed Refusal) × %DM

Crude Protein Intake (CPI)= (Feed Offered – Feed Refusal) × %CP

Total Tract Digestibility
Digestion trial was conducted during the end part of the feeding trial. The feces were manually collected for 24 h for 7 consecutive days from each animal. It was collected immediately at the time of defecation to avoid urine contamination. The total amount of feces was weighed and recorded for each animal. About 10% of well-mixed feces were collected from the total feces as samples. Feed offered and refusals were also collected daily for DM determination and other chemical analyses. All samples were analyzed for proximate components using the standard procedure of AOAC (2006). Dry matter digestibility (DMD) and crude protein digestibility (CPD) were computed using the formula below:

% Apparent Total Tract Digestibility =

\[ \left( \frac{(\text{Feed consumed} \times \% \text{Nutrient}) - (\text{manure output} \times \% \text{Nutrient})}{\text{Feed consumed} \times \% \text{Nutrient}} \right) \times 100 \]

Simple Cost and Return Analysis
The benefits of HCF given to the animals were assessed by calculating the feed cost per kg, total feed cost, ADG, total kg gain, and feed cost per kg gain. The feed cost per kg was calculated by accounting for all the cost of feed ingredients used in the ration formulation and dividing it by the total kg of ration produced. Total feed cost was calculated by multiplying the total feed intake and the feed cost per kg. Feed cost per kg gain was calculated by dividing the total feed cost by the total kg gain, while the total kg gain was calculated by subtracting the final weight from the initial weight.

Feed Cost per kilogram (Php) = Total cost of all feed ingredients kg of ration produced

Total Feed Cost (Php) = Total feed intake X Feed cost per kg

Fig. 4. Ration preparation namely, a) Chopping of Napier, b) Weighing of feed ingredients, and c) Mixing of feed ingredients.
Average Daily Gain (ADG) = Final weight – Baseline weight

Total no. of days of feeding

Total Gain (kg) = Final weight - initial weight

Feed Cost per kg Gain (Php/kg) = Total Feed cost ADG

Statistical Analysis

All data were subjected to statistical analysis in a Randomized Complete Block Design (RCBD) using the paired difference two-sample t-test of the SPSS and Jamovi software. The differences between the means of the treatment groups were determined with 0.05 level of significance using Tukey’s HSD.

Scope and Limitation

This study focused on the effect of HCF on the growth and performance of buffalo calves in terms of average daily gain and total weight gain and feed cost. A total of 12 newly weaned calves served as experimental animals from the PCC Gene Pool Farm, Science City of Muñoz, Nueva Ecija. This study did not cover other factors such as the detergent fiber analysis (NDF, ADF, and CF) and gross energy (GE) due to lack of serviceable laboratory equipment as well as the impact of HCF on the health or well-being of buffalo calves, nor did it examine the potential environmental benefits or drawbacks of using HCF as a feed source.

Institutional Animal Care and Use Committee (IACUC)

The study was conducted with the approval of the PCC Research Ethics Committee (REC) and complied with the standards set by the REC.

RESULTS AND DISCUSSION

Nutrient Composition

The proximate composition of HCF at different growing periods from days 0 – 9 was presented in Table 3. Result showed that there were significant differences (P < 0.05) in the mean percentage of DM, CP, Ash and EE across the observation period. The DM and EE content decreased over time (Fig. 6). DM declined from 60.32% to 23.59% while EE declined from 5.48% to 2.06%. The DM content of HCF at day 9 (23.59%) was significantly lower as compared to days 0 – 7 but was comparable to day 8 (28.33%). In terms of EE, the HCF at days 5, 6, and 8 (2.47%, 2.06%, and 2.83%, respectively) was comparable and significantly lower as compared to HCF at day 0 (5.48%), 1 (5.35), 2 (4.53%), and 9 (3.92%). This result was expected because energy reserves were being utilized for the catabolism of starch to soluble sugar to support the metabolism and energy requirement of growing plants for respiration and cell wall synthesis (Naik et al. 2015). As the shoot continuously grew and developed, the reserved nutrients were exhausted progressively.

In this study, there was an increase in the CP content of hydroponic corn sprout from day 1 to 8 that increased its quality as fodder. This type of fodder is considered highly palatable and nutritious and can be produced at a low cost in various areas (Ndaru et al. 2020). The CP content of HCF at day 8 (10.21%) was significantly higher (P < 0.05) compared to the CP content of HCF at days 0, 1, 2, 3, 5, 6, and 8 (9.90, 8.08, 8.20, 8.64, 8.23, 9.24, and 9.35 %, respectively). These findings were similar to the observation of Gacutan et. al. (2021) who note that there is a decrease in the DM yield of corn sprouts after 6 d due to...
depletion of stored nutrients over time to support plant shoot growth. However, the decrease in DM led to an increase in CP from 3 d to 12 d due to the metabolic interconversion of nutrients. On the other hand, the ash content of HCF was highest (P < 0.05) on day 6 (2.01%) and day 8 (2.04%) as compared to days 0–6 and at day 9. Results from this study, which indicated the highest total ash content of HCF at day 8 of growth, were consistent with the report of Kide et al. (2015), who also note the highest ash content at day 8 of growth.

A study conducted by Gacutan et al. (2021) found that the % neutral detergent fiber (NDF) and % acid detergent fiber (ADF) of corn sprout fodder at different ages (3, 6, 9, 12 d) shows a significant increase in % ADF and % NDF of the corn sprouts. This increase is a result of the maturation of corn sprout, accumulation of fiber, and water stress. As the corn sprout grows, it undergoes changes in the structure and composition of its cell wall. Cell walls become thicker and highly lignified to help plants maintain structural integrity. Moreover, as sprouts grow hydroponically, it accumulates fiber over time. Water stress, on the other hand, causes the plant to allocate more resources towards the cell wall synthesis and lignification.

Furthermore, linear and quadratic trend analyses were also conducted (Table 3). Data showed a combination of linear and quadratic trends in terms of %DM and EE. Specifically, for %DM, a quadratic trend was observed from day 0 to 3, followed by a negative linear trend after day 3. In case of CP, a quadratic trend was observed, while for %Ash there was no clear pattern observed.

The results showed that the HCF on day 8 had significantly higher CP and Ash content with comparable DM and EE content at day 9. These findings supported the use of sprouting HCF on day 8 for feeding trial.

**Feeding and Growth Performances**

Table 4 showed the effect of partially replacing feed concentrate with HCF on the growth and feeding performances of buffalo calves. The initial weight of buffalo calves in T1 was 88.17 kg, while the weight of calves in T2 was 86.17 kg. At the end of the feeding trial, the weight of calves in T2 reached 144.50 kg with an ADG of 648.15 g and a total weight gain of 47.42 kg, compared to the final weight of animals in T1 with an average final weight of 135.58 kg, 526.86 g ADG, and 58.33 kg average total weight gain. However, no significant differences were observed in the calves’ average final weight, ADG, and average total weight gain (P = 0.403, 0.151, and 0.151, respectively). These results agree with the observation of Sneath and McIntosh (2003) during their review of hydroponic fodder. They reported that in relation to beef cattle, most of the trials conducted on the evaluation of livestock performance showed no advantage when HCF was included in the diet, especially when it is replaced with highly nutritious feeds. However, this observation is in contrast with the results of Rajkumar et al. (2018) who found that crossbred calves supplemented with 7% CP from HCF revealed a significantly better growth performance than calves fed without HCF.

**Nutrient Intake**

Daily nutrient requirements of buffalo calves weighing 150 kg BW require 4.10 kg DM and 0.486 kg CP to achieve 0.5 kg ADG (Kearl 1982). Results showed that the average

![Fig. 6. Linear trend for DM, CP, Ash, and EE of corn sprouts from days 0 to 9.](image-url)
daily dry matter intake (DMI) for both T1 and T2 increased over time from the 1st to the 3rd mo (T1: 1.41, 3.15, and 3.32 kg; T2: 1.28, 2.92, and 3.37 kg). The DM requirement of the calves based on body weight was not met from the 1st to the 3rd mo of the feeding trial. However, during the 2nd and 3rd mo, the DMI nearly met the requirement, with a small difference compared to the DM requirement (T1: 2.7, 3.2, and 3.65 kg; T2: 2.9, 3.3, and 3.9 kg). This observation was attributed to the physiological growth and development of calves. As the calves grow, their nutrient requirement and intake also increase. However, the transition period of calves from milk feeding to weaning or the change in feeding pattern from liquid to solid contributes to the low DMI of the experimental animals as explained by PCC (2009), where the growth rate slowly increased 3 mo after weaning, when the calves can adjust to solid feed. Results showed that the average daily DMI of animals in T1 and T2 from 1st to 3rd mo was comparable \((P = 0.689, 0.452, \text{and} 0.654, \text{respectively})\); however, no significant difference between means was observed. Moreover, CPI was not met only during the 1st mo of the feeding trial (0.23 kg and 0.199 kg for T1 and T2, respectively). The average body weight of the experimental animals during the 1st mo of the feeding trial was 104.75 and 106 kg for T1 and T2, respectively. According to Kearl (1982), a 100 kg buffalo requires 0.374 kg daily protein. During the 2nd and 3rd mo of feeding, there was a gradual increase in CPI observed in both treatments. However, no significant difference \((P = 0.455, 0.125, \text{and} 0.051, \text{for the 1st, 2nd, and 3rd mo, respectively})\) between CPI means was observed. The results are in contrast with Rajkumar et al. (2018) who reported a higher DM intake in calves fed with HCF.

Although the difference in DMI and CPI was not statistically significant, these findings suggest that substituting 50% of corn fodder with starter concentrate in calves is effective without adversely affecting their growth performance and nutrient utilization.

**Apparent Total Tract Digestibility of Nutrients**

The nutrient digestibility of HCF was shown in Table 6. After 7 d of fecal collection, laboratory analysis of fecal samples, and computation of nutrient digestibility, data revealed that the diet containing corn fodder had no significant difference \((P = 0.070)\) between means of DM digestibility compared to the diet without corn fodder. The CP digestibility was also found unaffected by HCF feeding, and no significant difference between the diets was observed \((P = 0.09)\). This means that a 50% level of substitution of HCF to feed concentrates has comparable nutrient digestibility, a result supported by Canton-Castillo et al. (2020) who found that hydroponic corn forage can be used as an excellent source of forage for lambs at 40% inclusion in the diet to replace commercial feed. This result, however, is in contrast with the report of Rani et al. (2019) where significant differences in the groups’ *in vivo* digestibility of DM and CP were observed among the treatment groups fed with HCF to crossbred calves. Similarly, the study conducted by Kide et al. (2015) found that substituting of up to 40% with hydroponic maize and barley fodder improved the nutrient digestibility and dry matter intake of growing goats, which differs from the result of the present study. Moreover, results of a recent experiment by Ebenezer et al. (2021) also showed that supplementation of HCF at 25% and 50% improved nutrient digestibility in Tellicherry buck kids, specifically enhancing dry matter digestibility.

The ruminal function of calves is influenced by several factors including the quality of the feed they consume, such as high crude protein (HCF) feeds. HCF has longer retention time in the rumen compared to concentrates, allowing for better fermentation and digestion. Feed ingredients low in protein content may have lower protein digestibility, which means that less of the protein is broken down and absorbed by the animal. The HCF crude protein digestibility has been found comparable in both T1 and T2, indicating that HCF is highly palatable and easily digestible and has a high CP content (Husain et al. 2018). As a result, HCF was considered a favorable feed option for calves, likely contributing to their ruminal function by providing highly digestible protein for optimal growth and performance.

**Cost of Production**

The cost breakdown for producing hydroponic corn fodder as well as the cost of feeding using 2 distinct feeding rations (T1 and T2) was shown in Table 7.

### Table 6. Apparent total tract digestibility of hydroponic corn fodder.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatment (mean ± SEM)</th>
<th>F tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – Control-0% HCF + 48% Concentrate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 – With HCF Supplementation 24%Concentrate + 24% HCF</td>
<td>Mean ± SE diff</td>
</tr>
<tr>
<td></td>
<td>F (1,9)</td>
<td>Sig. ((p\ value))</td>
</tr>
<tr>
<td>%Nutrient Apparent Digestibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Protein</td>
<td>63.58 ± 2.21</td>
<td>5.27 ± 2.86</td>
</tr>
<tr>
<td>Dry Matter</td>
<td>67.44 ± 3.50</td>
<td>-15.06 ± 7.33</td>
</tr>
</tbody>
</table>

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The cost of producing a kilo of HCF (as fed basis) after a simple cost and return analysis was PhP 9.91 (Table 7). Feed cost per d for a diet with hydroponic corn (T2) was PhP 78.03 and was statistically higher \((P = 0.003)\) compared to a diet without hydroponic corn (T1) with PhP 66.66 per animal per d. This finding was supported by Rahman et al.’s (2019) observation, which suggests that the cost analysis does not support the idea to produce and feed hydroponic sprout also known as hydroponic fodder instead of using grains directly as concentrate feed. Nonetheless, the calculated cost per kg BW gain of animals showed no significant differences.

The calculated body weight (BW) gain of animals in T2 at PhP 124.75/kg BW gain was comparable to the cost per kg BW gain of calves in T1 which was PhP 132.42. This means that a 50% reduction of feed concentrates and the substitution of corn fodder in the diet fed to growing calves resulted in faster and heavier growth. It also presented a lower feed cost per kg BW gain as it requires a small area for the production, less water consumption, and can be grown in numerous places. This technology can be implemented in regions where forage production is limited (Ghorbel et al. 2022). Feeding dairy animals is incomplete without including green fodder in their diet. The inclusion of green fodder in the ration of dairy animals decreases the amount of concentrate feeding, thus increasing profit. Therefore, for economical and sustainable dairy farming, fodder production year-round was highly essential.

In the study of Naik et al. (2014), it is concluded that feeding HCF to lactating cows increased the digestibility of nutrients and milk production, leading to an increase in net profit. The production of HCF is also more

| Table 7. Calculated production cost per kg of hydroponic corn fodder produced. |
|---------------------------------|-----------------|
| Items                           | Amount          |
| A.                              |                 |
| Materials and construction cost |                 |
| · 3 wooden shelves with 3 layers plastic screen @ 1,500/unit |                 |
| · 90 plastic sprouting trays (15 trays per layer X 2 layer per unit X 3-unit wooden shelves) @ Php166.66/pc |                 |
| · 25 m insect net as cover @ Php 50.00/m |                 |
| · 2 pcs plastic drum (200-liter capacity) @ Php 1200.00/pcs |                 |
| · Depreciation cost, 3 yr | 2 073.77         |
| · Total Sprouting cost, Php 23 149.40 |                 |
| · Calculated for 92 d (duration of feeding trial) |                 |
| B.                              |                 |
| Seed Cost                       |                 |
| · Feed grade yellow corn seeds@ Php19.00/kg | 15 588.00       |
| · Total seed cost Php15 732.00 (9.62 kgs for 9 Trays X 90 d) |                 |
| C.                              |                 |
| Water usage                     |                 |
| · Requirement 1 cubic m\(^3\) per d | 90.00           |
| · Cost per m\(^3\), Php 1.00 |                 |
| · Total water cost per d (Php 1 X 90 d) |                 |
| D.                              |                 |
| Labor cost                      |                 |
| · Requirement, 3 hr per d (soaking, watering, harvesting) | 16 560.00       |
| · Prevailing labor cost @ PCC, Php 488/d or Php 61.00/hr |                 |
| · Total labor cost, Php 183.00 for 92 d |                 |
| E.                              |                 |
| Total Cost of Production        |                 |
| · Summation of A+B+C+D | 34 231.66       |
| F.                              |                 |
| Cost of sprout per kg as fed    |                 |
| · Total fresh herbage yield, average of 4kg HCF/kg seed | 9.91            |
| · 9.2kg/d X 4 X 90 d = 3 464kg |                 |

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economical with regard to typical production costs including expenses for seeds, water, and electricity. HCF can also replace 100% of the animal’s diet and has been scientifically proven to increase the digestibility of other feeds.

CONCLUSION

Supplementation of hydroponic corn fodder at a 24% level (50% reduction of feed concentrate) as an alternative to feed concentrate in the diet of water buffalo calves provided a number of benefits with no adverse effects. The concentrate ratios of T1 (48:52) and T2 (24:76) ratio were comparable in terms of growth performance, dry matter feed intake, and nutrient digestibility. Furthermore, the use of hydroponic corn fodder was shown to be cost-effective, with a lower average cost per kg gain compared to current feeding practices. It served as an alternative to the use of feed concentrate, providing a more cost-effective solution.

This research highly recommended the use and integration of hydroponic corn production as a sustainable fodder source for water buffaloes. Moreover, the installation of greenhouse hydroponic technology was highly recommended to produce high-quality corn fodder. Finally, other species of grains such as sorghum, mungbean, and other forage crops can be evaluated for their nutrient composition (proximate and detergent fiber fraction) and potential use as fodder to meet the nutritional requirements of not only calves but also growing and lactating water buffaloes.

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