The potential of dairy farm development in Coastal Area, Bangka Botanical Garden, Pangkalpinang, Indonesia

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Abstract. This research aims to analyze potential development dairy farming in the lowlands and to be carried out as an evaluation to increase productivity. This study can be a case study for other areas that will establish dairy farms, especially coastal areas. Design of research is a descriptive study with data collection procedures using data collection, sample testing, data sorting, data tabulation, and data discussion. The parameters evaluated consist of cattle, physiological status, cows productivity, microclimate pen environment, physiological response of cows, digestibility of feed, and quality of milk products. The data calculated with average and standard deviation to determine the data-centre and will provide with each test indicator's conclusion value.

1. Introduction
The consumption rate of fresh milk in Indonesia has increased by 1.22% during 2019 – 2020 [1]. Due to people in Indonesia who are increasingly concerned with nutritional needs in routine consumption needs, Milk consumption has increased. National milk production is deemed unable to meet total domestic consumption, so the government has decided to import skim milk from other countries. Milk production in Indonesia has low productivity, namely 11 L per day [2]. According to Makin, the cause of dairy cattle’s low productivity is due to various factors, both in terms of maintenance management and the ability of livestock to produce milk [2]. Developments in the establishment of dairy farms in new areas need to be done to increase national fresh milk production. The establishment of dairy farms in tropical areas like Indonesia now depends not only on geographical conditions in the highlands. Human migration to the highlands has pushed aside some dairy farms. Another consideration in establishing a cattle farm is that it must be close to its market prospects because fresh milk is a perishable product, one of the cattle farms established in lowland locations in the Bangka Botanical Garden in Pangkalpinang.

Dairy cattle farms at BBG are unique compared to dairy farms in other areas because they are located in lowland areas and close to the coast. Efforts to develop a dairy farming strategy in the city of Pangkalpinang need to be carried out as an evaluation aimed at increasing productivity and as a case study for other areas that will establish dairy farms.

2. Methodology
The research was conducted from July to November 2020 in Bangka Botanical Garden (BBG) dairy farm located at Jalan Raya Pasir Padi, Temberan Village, Air Itam Distrik, Pangkalpinang City,
Bangka Belitung Islands Province. This research has carried out parameter tests in several places consisting of the Pangkalpinang Food and Drug Supervisory Agency (BPOM) laboratory for fresh milk tested, the Inter-University Central Laboratory (PAU) of IPB University and the Dairy Nutrition Laboratory of the Department of Nutrition and Feed Technology, IPB University for feed and faecal tested. The stages of this research have started from the search for standard data to evaluate dairy farming’s success. Field testing and observations have been carried out with the following parameters:

1. Observation of dairy cows performances [3] by observing all cows in a lactating pen. The recording is divided into population, reproduction, and milk production. Individual performance has been measurements such as cow’s heart girth used the rondo tool, Hip height and body weight used cow measuring stick, and body conditioning score with a value range of 1 - 5 (0,25-point scale) by touched of the spine (backbone), loin and hip (rump) to see fat deposits

2. Feed quality testing [4] was carried out by sampling forage and concentrate for three consecutive weeks. The nutrient content analysed in the proximate test was dry matter, ash content, crude protein, crude fat, crude fibre, and macro minerals (Ca and P).

3. In Vivo Nutritional Digestibility Test [5] was conducted on five cows with different pen positions (side, middle-side, and middle). Feed consumption is calculated by weighing the feed given minus the remaining feed every day. Digestibility was carried out by holding the faeces for 24 hours and taking 10% samples of the whole stool. The faeces that have been collected are analysed in a proximate test to determine the nutritional content. The calculation of the digestibility (pseudo) of feed ingredients is carried out with the formula:

\[
\text{In vivo digestibility} = \frac{\text{nutrient feed consumed} - \text{nutrient of faeces}}{\text{nutrient feed consumed}} \times 100\%
\]

4. Physiological response measurement [6] is done by selecting five cows with the pen position at side, middle-side, and middle. The physiological response of cows measured were heart rate (Hr) used a stethoscope, respiratory frequency (Rr) used a counter, rectal temperature (rT) measured with a digital rectal thermometer, skin temperature (sT) measured with an infrared thermometer were taken on the back (A), chest (B), upper leg (C), and lower leg (D) and body temperature (bT) measured by the formula McLean et al 1983:

\[
bT = (rT \times 0.86) + (sT \times 0.14)
\]

notes: bT (body temperature), rT (rectal temperature), sT (skin temperature)

5. Fresh Milk Characteristics Test [7] The sampling of milk was carried out by direct storage of milk from the nipple into a sterile container on five sample BBG cows. Milk samples were done in the morning and afternoon milking process in each third week. Testing physicochemical characteristics (fat content, solid non-fat (SNF), density, lactose, protein content, and freezing point) using a lactoscan machine. The study of the microbiological quality of fresh milk includes analysis of Total Plate Count (TPC), Staphylococcus aureus and Enterobactericea.

The data will be processed with descriptive statistics to determine the average and standard deviation with the formula:

\[
\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}, n \neq 0 \quad \text{and} \quad \sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}
\]

3. Results and Discussion

Bangka Botanical Garden (BBG) is geographically located at the coordinates 2 ° 07'07.1 "S 106 ° 09'51.8" E. BBG dairy farm have established since 2009 with clean system available like milking machines, milk processing installations, fertilizer processing installations, marketing of dairy products, and biogas processing. Data Observation of the BBG dairy cattle population 2020 is shown in table 1. The data observation focused on cow lactation pens with population 41 cows. Results of the performance value of dairy cows at BBG are presented in Table 2. The source of dairy cattle breeds in BBG is a cross between pure FH cattle which in 2009 was imported from New Zealand. Individual
performance of dairy cows in BBG have a large body posture compared to PFH cattle generally in smallholder farms. The body performance of BBG dairy cows is shown in Table 2.

Table 1. Dairy Livestock Population at BBG of August 2020.

| Livestock status | Head | Livestock Unit | Percentage (%) |
|------------------|------|----------------|----------------|
| Brood stock Female | 97   | 97             | 80.33          |
| Brood stock Male  | 2    | 2              | 1.66           |
| Young calf Female | 30   | 15             | 12.42          |
| Young calf Male   | 3    | 1.5            | 1.24           |
| Calf Female       | 10   | 2.5            | 2.07           |
| Calf Male         | 11   | 2.75           | 2.28           |
| total             | 153  | 120.75         | 100            |

The population of dairy cattle in BBG is dominated by female brood stock (80.33%). This percentage is quite ideal because, in dairy farming, the percentage of female livestock must be the highest so that the efficiency of dairy farming is high.

Beside the value of individual performance dairy cows, cows in BBG show good results and exceed SNI [3]. The evaluation of the reproduction cows performance in BBG were seen in table 2, evaluation of calving interval (CI) and service per conception (S/C) is not much different from the standard. The ideal CI distance for dairy cows is 12 months with nine months of pregnancy and three months of dry period [8], dairy cows are expected to give birth once a year. The reproductive management of dairy farming at BBG has been good with clear records.

Table 2. Performance Dairy Cows of BBG.

| Parameter                     | Result                | Standard          |
|-------------------------------|-----------------------|-------------------|
| Individual performance (15-18 month) | 189.98 ± 11.32        | Min 155 cm        |
| heart girth (cm)              |                       |                   |
| Hip height (cm)               | 137.84 ± 5.62         | Min 121 cm        |
| Body weight (kg)              | 450.59 ± 47.59        | Min 300 kg        |
| Milk production (L days⁻¹)    | 7.74 ± 0.33           | Min 15 for tropical|
| BCS (1-5)                     | 3.5 – 4               | 3 – 3.5           |
| Calving interval (month)      | 14.46 ± 1.29          | 12                |
| Service / conception          | 1.93 ± 0.75           | 1-2               |
|                               |                       |                   |

Milk productivity in a BBG farm is calculated by recording milk production during the milking process. Based on research Makin and Suwarnanto [9] lactation duration is calculated from the start of the cow producing milk until the cow is dried. Management of daily milk production records on BBG farms is recorded directly in population production, not production per individual. Observation of daily milk production in BBG farms is provided in Table 3.

Table 3. Milk Production BBG.

| Month | Milk production time | Average of cow lactation | Lactation day⁻¹ |
|-------|----------------------|--------------------------|-----------------|
|       | Morning | Afternoon | Total | Morning | Afternoon | Total | Morning | Afternoon | Total |
| Jul   | 203.97 ± 10.82       | 124.90 ± 9.79            | 328.87 ± 16.82  | 42.45 ± 0.57 | 7.74 ± 0.33 |
| Aug   | 164.97 ± 15.89       | 110.03 ± 7.21            | 275.00 ± 20.50  | 38.65 ± 1.80 | 7.11 ± 0.29 |
| Sep   | 131.40 ± 8.61        | 86.83 ± 6.37             | 218.23 ± 13.30  | 34.47 ± 1.72 | 6.34 ± 0.32 |

Daily milk production on BBG farms only ranges from 6 - 7 L day⁻¹. This result is relatively low when compared to research BPS [1] said average milk production rate of traditional dairy farming in Indonesia is 11 L day⁻¹, but if compared with research [10] dairy farm milk production in Karo...
Regency had located upland area milk production only 6.828 L day⁻¹ is lower than BBG. The cause of low milk production is related to the increasingly limited capacity of dairy cows and grass land [11]. Daily milk production at BBG in the last three months of observation is relatively the same. The milk production curve for each cow is different, and the lactation period's status also varies. Milk production will start after the cows are pregnant and released after giving birth to calves. The higher the reproductive efficiency, the lower the production process's costs [12] BBG should record daily milk production by sampling at the individual level per cow, it used management to evaluate cows that produce high milk or low as a reference when doing culling or knowing the physiological status. The one of the factors affecting milk production in terms of external input were feed nutrition and physiological response.

The feed for dairy cows in BBG consists of forage and concentrate. The forage given type of *Pennisetum purpureum* was planted in BBG's garden. Elephant grass or in English called Napier grass, is grass from Africa with high productivity, this type of grass can grow in areas with medium quality soil content [8]. This is why elephant grass is planted in BBG because it is a former swamp. In the dry season the soil is relatively dried so it is expected that the type of grass grown has high environmental adaptation. The grass quality is influenced by soil nutrition and cutting age. Grasses on BBG were cut when at least two months old because it has a high quantity even though it is low quality and before the grass is given it will be chopped. The additional feed like a concentrate must be given to BBG cows that have high quality so it can achieve milk production capability. The quality of concentrate is more high result that compiled SNI [4] standard content lactation feed with criteria DM min 14%, ash min 10%, CP min 14%, CF max 7%, Ca 0.6 – 1.2 % and P 0.4 – 0.6 %. Additional feed or concentrate in BBG consists of palm oil meal, pollard, tofu dregs, molasses, and mineral mix. The concentrate was given by an impregnation method wherein 100 kg consisted of 65% palm oil meal, 20% pollard, 15% tofu dregs, two packs (2 kg) of mineral mix consisting of Ca and P minerals as a feed premix. Giving molasses is done by diluting the molasses with water and then pouring it on the grass during the feed while daytime to increase palatability because at that time some chopped grass had too dried.

Proximate feed quality is listed in table 4. Forages as a cows feed is more critical than concentrate because it affects the milk to produce fat content [13]. Giving more forage causes a high quantity of milk and more concentrate can make fat content in milk is high [14]. The quality of BBG feed can be seen in Table 4.

| Table 4. Laboratory Test Results of Feed Quality and Digestibility in BBG. |
|---------------------------------------------------------------|
| **Parameter**        | **Forage** | **Concentrate** |
|----------------------|------------|-----------------|
| **Proximate**        |            |                 |
| DM (%)               | 20.00 ± 1.42 | 60.25 ± 3.65    |
| Ash (%)              | 4.74 ± 1.15  | 6.21 ± 0.33     |
| Crude Protein (%)    | 3.58 ± 0.87  | 14.64 ± 0.28    |
| Crude Fat (%)        | 1.12 ± 0.13  | 3.95 ± 0.19     |
| Crude Fibre (%)      | 32.85 ± 1.97 | 7.93 ± 2.98     |
| **Mineral**          |            |                 |
| Ca (%)               | 0.26 ± 0.02  | 1.36 ± 0.30     |
| P (%)                | 0.12 ± 0.08  | 0.77 ± 0.11     |
| **In-vivo Digestibility** |           |                 |
| DM (%)               | 61.07 ± 3.07 |                 |
| OM (%)               | 53.52 ± 3.66 |                 |
| Crude Protein (%)    | 54.35 ± 3.65 |                 |
| Crude Fat (%)        | 67.56 ± 2.57 |                 |
| Crude Fibre (%)      | 59.18 ± 3.24 |                 |

Note: *PAU IPB Lab Test Result, Dairy Nutrition Lab Test Results, In Vivo Digestibility Observation Calculation Results
In Table 4, it is known that the average digestibility of the ration is not optimal. The digestibility is quite useful when the digestibility reaches a value of more than 60% [15]. An increase in dry matter and organic matter digestibility can indicate fibre digestibility is high. The higher the dry matter digestibility value of the ration shown more efficiently the nutritional needs of the cows. Based on the analysis results, it is known that the quality of the feed is good enough. The calculated amount of feed is still insufficient so that the nutrition of the feed is not sufficient to achieve maximum milk production. The in vivo digestibility is low and can be caused by heat stress because the frequency of cows drinking is increased. It makes the cow's stomach full quickly and digestibility will decrease [16]. The handling prevention of cows experiencing stress with cattle pen management to avoid environmental heat stress.

Dairy cows at BBG based on cattle pens are divided into eight sections like a lactation pen, dry cows pen, pregnant cows pen, isolation cages, breeding pens, calf pens, young calf pen, and isolated pen. Making a pen should have paid attention with free space for cattle to move. The pen with stables not according to the cows size can affect injury and disruption to dairy cows leg health [17]. The pen serves to protect livestock from weather changes. On the microclimate observation of the dairy cow pen in the lactation pen, the observations are presented in Table 5.

| Time  | Temperature (°C) | Humidity (%) | Wind Velocity (m/detik) |
|-------|-----------------|--------------|------------------------|
| 06.00 | 25.5 – 26.2     | 50 – 84      | Maks 0.5               |
| 10.00 | 26.6 – 28.5     | 54 – 78      | Maks 2.4               |
| 13.00 | 28.7 – 30.6     | 48 – 53      | Maks 3.0               |
| 16.00 | 27.4 – 30.3     | 52 – 64      | Maks 1.1               |
| 19.00 | 25.4 – 27.8     | 54 – 74      | Maks 1.3               |

Environmental temperature can affect feed consumption and milk production [5]. The type of FH dairy cow originates from subtropical areas. If kept in tropical areas, it will get heat stress, which will cause excessive heat build-up in the cow's body. The physiological response consisting of the frequency of respiration, body temperature, and heart rate can reference the livestock’s comfort level. The physiological response of lactating BBG dairy cows is presented in Figure 1.

The results of the observations in Figure 1 indicate that BBG dairy cows do not experience extreme heat stress. Indicators of cows experiencing heat stress if they have signs such as rectal temperature 38.2 - 39.1 °C, skin temperature 33.5 - 37.1 °C, body temperature 38.32 - 38.63 °C, respiration frequency 27 - 56 times/minute and if heart rate ≥79 times/minute experience stress 32 °C [5]. Continued heat stress in livestock results in increased drinking water consumption, decreased milk production, increased urine volume, and decreased feed consumption [18]. FH dairy cows have the best production performance when kept in an 18.3 °C and 55% humidity. In contrast, BBG locations have microclimate milk cows at 25-30 °C and high humidity up to 80%.

The quality of milk in BBG dairy cows in table 6 shows that it has a high-fat content. Based on Table 4, the quality of feed ingredients for BBG dairy cows has a high-fat content. Besides that, the consumption of concentrate in dairy cows in BBG is more dominant than forage. Consumption of concentrate will increase the production of fat globules in milk [19]. The lump of milk fat in Holstein Friesian cows averages about 1.5 g / 100 g of milk fat and consists of 60 percent protein and 40 percent phospholipids, along with small amounts of other fats [20]. The milk that has high-fat content can be an indication that milk protein levels are also high. The results of the analysis of protein content in BBG fresh milk have good quality. The results of microbiological contamination are low. It can be caused by sending or treating milk samples to contaminants that contaminate fresh milk. The presence of Enterobacteriaceae in fresh cow's milk can cause damage to milk [21]. One of the Enterobacteriaceae families is Escherichia coli. These bacteria can be contaminated through the milk
handling process, such as in the milking process in a cage, handling milk after milking, processing cow's milk, or distributing milk to consumers. Contamination can come from humans or livestock.

Figure 1. Physiological response of lactating cow

Table 6. Quality of BBG Fresh Milk.

| Parameters                     | Sample time | Morning | Afternoon | Standard SNI |
|--------------------------------|-------------|---------|-----------|--------------|
| Condition Milk                 |             |         |           |              |
| Aroma scan                     | Normal      | Normal  | Normal    |              |
| Colour                         | White milk  | White milk | White milk |              |
| Flavour                        | Normal      | Normal  | Normal    |              |
| Physicochemical of milk        |             |         |           |              |
| Fat (%)                        | 3.03 ± 0.07 | 4.05 ± 0.42 | Min 3.0 |              |
| Solid Non-Fat (%)              | 7.45 ± 0.07 | 7.33 ± 0.23 | Min 7.8 |              |
| Density (g/mL)                 | 2.664 ± 0.60 | 2.460 ± 0.94 | Min 1.027 |              |
| Lactose (%)                    | 4.1075 ± 0.01 | 4.03 ± 0.12 | -         |              |
| Protein (%)                    | 2.81 ± 0.06 | 2.68 ± 0.09 | Min 2.8 |              |
| Freezing Temperature (°C)      | -0.4635 ± 0.0 | -0.4630 ± 0.0 | -0.520 - -0.560 | |
| Microbiology Contaminant       |             |         |           |              |
| TPC (CFU)                      | 2.6 x 10³   | 3.9 x 10³ | 1 x 10⁶ |              |
| *S. aureus* (CFU)              | < 10        | <10     | 1 x 10²  |              |
| *Enterobacteriaceae* (CFU)     | 2 x 10²     | 1.6 x 10⁵ | 1 x 10³ |              |

4. Conclusion
Dairy farming in BBG, even though it is located in a coastal area has a potency to be developed. The average daily milk production day⁻¹ must be increased and make sure quality is good. The coastal location does not indicate cows to be stressed because observing has normal physiological responses.
Since birth, the cows have adapted to the environment, and the pen construction is good enough. Strategy to increase milk production with give forage feed minimal 10% of body weight.

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