Provision of location-specific agricultural waste feed to Sumba Ongole cattle's performance

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Abstract: The study focuses on the feeding of by products on the performance of Sumba Ongole cattle. The byproduct is in the form of concentrate and originates from the site-specific agricultural leftover. The expected goal is that Sumba Ongole cattle can optimally achieve their genetic potential. The research location was in East Sumba Regency, East Nusa Tenggara Province, which is the source of local Ongole cattle. The study used 15 Sumba Ongole cows consisting of seven pregnant cows, four male calves, and four female calves. Basal feed uses rice straw, while the agricultural byproduct consists of several sources, rice bran, peanut straw, corn straw, corncob, leaves of river tamarind, leaves of Gliricidia sepium, and cassava. The results showed that the average change in body weight of broodstock cattle receiving concentrated treatment was higher than those that received bran. On an in-vitro basis, this is consistent with high crude fiber content (36%), low dry matter digestibility (25%), and low bran organic matter digestibility (27%). For the average weight gain in calves, the local concentrate treatment consistently shows crude protein as much as 12.1% compared to rice bran 5.6%. To improve the cattle's productivity, giving the local-based concentrate is highly recommended, but the presence of rice bran still critical because of its ability to improve daily weight gain and also its high digestibility in dry matter, organic matter, and Total Digestible Nutrients.

1. Introduction
The performance of livestock is the result of the influence of heredity and the cumulative effect of environmental factors experienced by livestock from the time of fertilization to the time the animal is measured and observed. Hardjosubroto [1] and Gunawan et al. [2] stated that livestock genetic factors determine the ability of livestock, while environmental factors provide opportunities for livestock to display their abilities. Next, Sunaryo [3] cites Otsuka et al. (1982) and Taszkia [4] as saying that the appearance of an animal is the result of a continuous growth process in the animal's life. Each component of the body has a different growth rate due to nature and the environment. Livestock production performance can be seen from body weight, body size, and growth rate.

Ongole Cattle (Bos indicus) has a vital role in animal husbandry's history of Indonesia. The Ongole bull came from Madras, India, imported to Java Island, Madura, and Sumba Island. At Sumba, the cattle are well known as Sumba Ongole (SO), further being sent and bred with Native Java Cattle to produce Ongole Crossbred. Ongole cattle and its crossbred is suitable for plowing rice fields because of its big frame, muscular body, tame, and calm temperament, resistant to heat and also well adapted with the harsh condition. Ongole Cattle from India firstly brought by Dutch East Indies Government to Sumba Island at the beginning of the 20th century, between 1906 to 1907. There were four breeds
brought by Dutch East Indies Government: (1) Bali Cattle; (2) Madura Cattle; (3) Java Cattle; and (4) Ongole Cattle. Later on, the Ongole Cattle became the most well-adapted and fast-growing commodity in the Sumba island, which had a long dry season.

In 1914, the Dutch East Indies Government decided that Sumba Island as the breeding center of pure Ongole Cattle. This effort happened by introducing 42 Ongole bulls, which were followed by 496 Ongole Cows and 70 Ongole calves. Based on the Annual report of East Sumba District Animal Husbandry Office [5], Sumba Island had exported six adult Ongole Bull in 1915. Four years later, or 1919, the export of Ongole Cattle had reached 254 before increasing to 828 in 1929. There was a trademark for the cattle, which is SO (Sumba Ongole) cattle. The next development, The Sumba became the breeding center of Pure Ongole Cattle under The President Suharto era through the Main Regulation of Animal Husbandry and Veterinary Number 6 Year 1967.

The technical difficulties of extensively rearing Sumba Ongole Cattle are Heat Stress and Feed Scarcity, which happens annually. Those hindrances have happened for three to four months of dry seasons, which is very long. Feed deficiency mainly happens because of production difficulty during rearing and makes 20% less Body Weight comparing with the rainy season. For broodstock cattle, the effect makes some delay on reproduction activity, which appears by a long calving interval of as much as ± 1056 days [6].

The agricultural byproduct such as fine rice brand comes from local rice milling industry in Sumba Island. Meanwhile, the casava becomes a feed alternative but is still not well utilized yet. A previous study indicated that giving the agricultural byproduct from local specific sources can improve the Ongole Cattle during lactation. There are several ingredients, including fine rice brand, corn hay, dry gliricidia’s leaves, river tamarind, corn starch, and also protein source feed to Sumba Ongole Cattle with various treatment (3 kg/head/day and 45% concentrate) inside the ransom of lactating period of Ongole Cattle can improve from 0.44 kg/head/day to 0.50 kg/head/day daily body weigh. Meanwhile, the treatment in the late pregnancy broodstock cattle (8 months to 9 months) can improve calves growth and reach oestrus then to pregnancy faster comparing with the non-concentrate treatment [7, 8].

The purpose of the study is to get the optimum performance of Sumba Ongole Cattle base on its genetic potentiality through concentrate treatment with the agricultural byproduct.

2. Materials and methods

The study was conducted in East Sumba Regency by using 15 Ongole Cattles consists of 7 pregnant cows, four male calves, and four female calves. The basal feed comes from rice straw while agricultural byproduct consists of several ingredients: (1) rice bran; (2) peanut straw; (3) corn straw; (4) corncob; (5) milled corn; (6) dry gliricidia’s leaves; (7) river tamarind; and (8) casava. The study uses two parts of the experiment, in-vitro and in-vivo

2.1. In-vitro experiment

The In-vitro experiment used the Randomized Complete Block Design (RCBD) with eight treatments and three replications (8x3). The replications happen in taking ruminal fluid and acts as a block. There are eight treatments for study: (1) rice bran; (2) peanut straw; (3) corn straw; (4) corncob; (5) milled corn; (6) dry gliricidia’s leaves; (7) river tamarind leaves; and (8) casava.

The in-vitro digestibility experiment uses a method from Tilley and Terry in 1980. Based on this method, the microbes’ fermentation needs 96 hours of incubation to ferment the sample. The fermentation is being stopped by dipping the syringe into ice water. Subsequently, the centrifugation applies to the sample under 15,000 rpm before harvesting the residue using Whatman 41 filter paper. The Dry Matter (DM) measurement of harvested residue is using an oven at 105°C temperature. Meanwhile, The Organic Matter (OM) Measurement is using tenure with 550°C temperature.

There are several variables from in-vitro measurement: (1) Dry matter; (2) Organic matter; (3) Total Digestible Nutrient; and (4) Nutrient content from the proximate analysis. Then, the results are
analyzed using the analysis of covariance. If there are differences, the result will be tested further using Duncan’s test. The mathematical models of RCBD for the study as follows:

\[ Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij} \]  

(1)

Information:

- \( Y_{ij} \) = Observation Result
- \( \mu \) = overall mean
- \( \alpha_i \) = the effect of concentrate treatment
- \( \beta_j \) = effect of the j\textsuperscript{th} block
- \( \epsilon_{ij} \) = experimental random error of treatment i\textsuperscript{th} block j\textsuperscript{th}

\( i = 1,2,3,4,5 \)
\( j = 1,2,3 \)

2.2. In-vivo experiment

The In-vivo experiments were using two kinds of concentrate: (1) Concentrate on broodstock cattle with 10.1% protein; and (2) Concentrate for a calf with 12.1% protein. The experiments use the Randomized Complete Block Design (RCBD). There are two treatments in ransom. Meanwhile, the block uses Body Weight (BW). Its BW places the cattle. Then the ransom treatment is applied randomly for each block.

The ransoms for pregnant cow and male Ongole calve are consist of 50% rice straw and 50% concentrate, which is measured using DM. The treatment is explained further as follows:

1. \( P_1 \) = Rice Straw 50% + 50% concentrate
2. \( P_2 \) = Rice Straw 50% + 50% rice bran

The feed was given twice daily: (1) morning at 07.00 AM Central Indonesian Time; and (2) 03.00 PM Central Indonesian Time. For feed, the rice straw was given together with concentrate for both times. Meanwhile, drinking water is given ad-libitum.

There are three-stage of in-vivo experiment: (1) Adaptation phase; (2) Preliminary phase; and (3) Data collection phase;

2.2.1. Adaptation Phase. The adaptation phase took one week to give adaptation time to cattle under an experimental environment, including cowhouse and feed. However, Ivomex, the worm medicine, has to be given at 1.5 ml for each cattle before the adaptation phase. All of the cattle had taken the same feed from field grass and concentrate until the feed intake stables. The BW measurement happens at both the beginning and the end of the week in the adaptation phase.

2.2.2. Preliminary phase. The preliminary phase classifies the cattle into several groups base on the bodyweight at the end of the adaptation phase. The preliminary phase happens to nullify the feed effect before the treatment. The given phase is also for stabilizing cattle's feed intake. It takes 14 days for the preliminary phase. Ivomex, the worm medicine, has to be given again at 1.5 ml for each cattle before the preliminary phase. Each of the given feed and residue has been measured in the preliminary phase. At the end of the preliminary phase, the cattle’s weight is measured before eating to know the BW at the beginning of data collection.

2.2.3. Collection data phase. The collection data phase takes three consecutive months to know the effect of feed intake treatment on the cattle's performance, such as consumption, digestibility, and average daily gain. As additional information, drink water is given ad libitum. At the collection data phase, there are several measurements for each treatment, including (1) feed consumption; (2) feed digestibility; and (3) BW measurement. Consumption measurement happens daily by weighing feed and residue for each cattle, then sampling it for the subsequent process. The next process is analyzing
DM and OM from the sample collected previously. The Nutrient digestibility is measured by taking note of feed intake, feed residue, and feces from each cattle. Sampling is also taken for feed intake, feed residue, and feces from each cattle.

2.3. Feed consumption measurement
Feed consumption measured from sample collection in collection data phase for three months which focuses on Body Weight Gain. However, the digestibility measurement uses the last ten days from the data collection phase.

2.4. Feed intake and residue sample collection
- Take the sample from both given field grass and concentrate 500 grams daily from the daily feed bank. Then, dry it under the sun. Composite the sample for cattle individually from each treatment, then do the sub-sampling before moving it into the oven (600°C for 24 hours). Finally, grind the sub-sample until it has 1mm particle for DM, OM, and Crude Protein (CP).
- If there is feed residue the next day, take 10% of it as the sample, then dry it under the sun. At the end of data collection, composite the sample from cattle individually for each treatment, then take 200 grams for sub-sample. Then, the oven (600°C for 24 hours) will be used to dry the sub-sample before the grinding process for Dry Matter and Organic Matter analysis. However, the grinding process only stops when the sample particle reaches 1mm.
- The Nutrient Consumption can be measured using the equation as follows:
  \[
  \text{Dry Matter Consumption (DMC)} = \left\{ \frac{\% \text{DM} \times \text{Feed Given (g)}}{\% \text{DM} \times \text{Feed Residue (g)}} \right\} - \left\{ \frac{\% \text{DM} \times \text{Feed Residue (g)}}{\% \text{DM} \times \text{Feed Residue (g)}} \right\} \tag{2}
  \]
  \[
  \text{Organic Matter Consumption (OMC)} = \left\{ \frac{\% \text{OM} \times \text{Feed Given (g)}}{\% \text{OM} \times \text{Feed Residue (g)}} \right\} - \left\{ \frac{\% \text{OM} \times \text{Feed Residue (g)}}{\% \text{OM} \times \text{Feed Residue (g)}} \right\} \tag{3}
  \]

2.5. Digestibility measurement

2.5.1. Feces sample collection. Feces sample collection happens during the data collection phase, precisely ten days, starting from the eleventh and being done at the twelfth week. During that period, collection happens for 24 hours. The procedure of feces sample collection is as follows:
- Feces sample collection is done by collecting 24 hours feces daily. Then it is mixed until homogenous and sprayed with 10% formalin to prevent rotting. Subsequently, the sample takes as much as 5% of total feces from that day before drying it under the sun.
- The whole feces sample is then composited from cattle individually for each treatment before getting its sub-sample as much as 1 kg. The sub-sample is dried using the oven (600°C for 24 hours) before the grinding process to refine the sub-sample with 1mm particle for several investigations such as DM, OM, CP, and digestible nitrogen, which is further checked using the following equation.

\[
\text{Dry Matter Digestibility (DM)} = \left\{ \frac{\sum \text{DM Consumption} - \sum \text{BK from feces}}{\sum \text{DM Consumption}} \right\} \times 100\% \tag{4}
\]
\[
\text{Organic Matter Digestibility (OM)} = \left\{ \frac{\sum \text{OM Consumption} - \sum \text{OM Feces}}{\sum \text{OM Consumption}} \right\} \times 100\% \tag{5}
\]

\[
\text{CP Digestibility (CP)} = \left\{ \frac{\sum \text{CP Consumption} - \sum \text{CP Feces}}{\sum \text{CP Consumption}} \right\} \times 100\%
\]
2.5.2. **Weight gain measurement.** To know the weight gain from each cattle, then BW measurement happens each week for twelve weeks data collection period. The BW measurement uses the equation as follows:

\[ \text{Body Weight Gain (g/head/day)} = \frac{\text{BW end} - \text{BW start}}{\text{Days of observation}} \]  

The result data are collected and analyzed using an analysis of covariance from treatment, which uses RCBD. If there are results that show a significant or very significant difference, then data will follow Duncan’s Multiple Range Test.

3. **Results and discussions**

3.1. **In vitro experiment**

The result of nutrient content from eight kinds of agricultural byproduct can be seen in Table 1.

| No | Concentrate Ingredients       | Nutrient Content |
|----|--------------------------------|------------------|
|    |                               | Crude Protein (CP)* (%) | Crude Fiber (CF)* (%) | Crude Fat (CF)* (%) | Crude Ash* (%) | Crude Dry Matter (DM) (%) |  |
| 1  | Corn Hay                      | 3.3               | 40.73              | 0.73               | 12.32          | 89.51                     |  |
| 2  | Rice Bran                     | 5.86              | 36.28              | 4.91               | 18.76          | 90.42                     |  |
| 3  | Casava                        | 2.95              | 6.47               | 0.95               | 4.54           | 87.76                     |  |
| 4  | Peanut Straw                  | 8.39              | 41.6               | 1.14               | 14.9           | 88.23                     |  |
| 5  | River Tamarind Leaves         | 19.59             | 19.84              | 2.7                | 13.57          | 87.65                     |  |
| 6  | Gliricidia’s leaves           | 16.43             | 31.13              | 1.5                | 14.21          | 87.08                     |  |
| 7  | Milled Corn                   | 7.82              | 2.61               | 1.98               | 1.49           | 89.05                     |  |
| 8  | Corncob                       | 2.75              | 37.67              | 0.4                | 2.61           | 93.73                     |  |

| Source: Analysis result from Feed and Nutrition Laboratory, Universitas Brawijaya, 2015. |

The data from table 1 shows that the Crude Protein Content (CP) from river tamarind leaves is the highest of eight kinds of concentrate's ingredient. Meanwhile, the lowest CP comes from corncob. Several studies reported that the protein content would positively connect with dry matter intake and organic matter [9, 10]. In contrast, protein content is negatively correlated with NDF content through the physical effect [11, 12].

The nutrient content is usually evaluated by proximate analysis. Chemistry composition and nutrient content are the potential value from the feed itself. Meanwhile, the actual value for cattle can be seen after that potential value of feed is reduced by the amount lost during consumption, digestion, absorption, metabolization inside the body [13].

The proximate analysis result becomes the quantitative estimation only for nutrients inside the feed but still unable to show the availability of nutrition value precisely. The ransom with the same chemical composition will not always affect the cattle because there are other factors: (1) palatability; and (2) digestibility.

The ruminant nutritionist experts struggle to predict the protein utilization and energy from the feed but find difficulties in precisely predicting the relationship between chemical composition and cattle utilization. However, there is an urgent need to have another way to analyze as long as a result is not varied, although the process is expensive and takes time [14]. Truthfully, feed evaluation is not enough from chemistry composition only, but also considering the other factors: (1) consumption; (2) digestibility; and (3) feed efficiency [15].
The average in-vitro digestibility of DM, OM, and TDN of concentrate ingredients can be seen in table 2. The casava and milled corn have higher DM, OM and TDN digestibility than other feed ingredients due to its low CF (table 2). The feed digestibility is affected by CF content. Parakasi [16] said that the higher CF could decrease the digestibility because there was lignin or silica content, which made more feed energy surpass into feces. Lubis [17] reported that the low CF content would result in a higher digestibility coefficient due to the cell wall component such as hemicellulose and lignin). Sutardi [18] also explained that OM degradation had a close connection with DM degradation because OM is also the component of DM. The reduction in DM digestibility will result in the drop of OM digestibility and vise versa.

### Table 2. Means of digestible DM, OM, and TDN (%) concentrate ingredients.

| Treatment       | Means of Digestibility (%) |
|-----------------|----------------------------|
|                 | DM | OM | TDN |
| Corn Hay        | 32.47\textsuperscript{b} ± 2.71 | 35.57\textsuperscript{b} ± 2.78 | 32.75\textsuperscript{b} ± 2.56 |
| Rice Bran       | 25.42\textsuperscript{a} ± 1.56 | 27.57\textsuperscript{a} ± 3.18 | 23.52\textsuperscript{a} ± 2.71 |
| Casava          | 65.08\textsuperscript{a} ± 4.68 | 65.34\textsuperscript{ab} ± 4.57 | 65.50\textsuperscript{ab} ± 4.58 |
| Peanut Straw    | 31.57\textsuperscript{b} ± 1.63 | 30.91\textsuperscript{b} ± 2.06 | 27.62\textsuperscript{b} ± 1.84 |
| River Tamarind Leaves | 33.10\textsuperscript{b} ± 1.45 | 33.01\textsuperscript{ab} ± 3.69 | 29.96\textsuperscript{ab} ± 3.35 |
| Gliricidia’s leaves | 32.96\textsuperscript{b} ± 1.85 | 32.42\textsuperscript{ab} ± 7.28 | 29.20\textsuperscript{ab} ± 6.55 |
| Milled Corn     | 64.82\textsuperscript{c} ± 0.53 | 65.7\textsuperscript{c} ± 0.75 | 67.96\textsuperscript{c} ± 0.77 |
| Corncob         | 23.82\textsuperscript{a} ± 3.06 | 26.49\textsuperscript{a} ± 3.46 | 27.08\textsuperscript{ab} ± 3.53 |

Annotation: Different alphabet in the same column indicates highly significant differences (P<0.01).

OM digestibility in casava and milled corn is higher more probably due to relatively lower ADF content. It is also reported that compared to NDF, the ADF has a higher correlation with feed digestibility [12, 15].

McDonald et al. [13] said that both forage and concentrate is consist of dry matter and also organic matter fraction. The organic matter is composed of the primary nutrient, which is very useful in cattle’s metabolism, including to grow and to become mature. The increase of organic content inside the casava and milled corn, especially in protein and carbohydrate, can improve the organic matter and dry matter digestibility.

Campbell et al. [19] said that there were some factors affecting ransom digestibility: (1) physical form of ingredients; (2) ransom composition; (3) feed flow rate inside the digestion tract; and (4) the comparison of ingredients of ransom. Focusing on casava and milled corn, the concentrate ingredients’ solubility inside the rumen fluid will accelerate the feed flow rate, which will affect the feed digestibility coefficient. The condition happens because it can stimulate rumen microbes to be more active to digest the forage.

### 3.2. In-vivo experiment

The Body Weight Gain (BWG) is the deviation between current body weight and initial body weight at the beginning of treatment or experiment. The BWG can indicate the cattle’s growth in a certain period. The in-vivo experiment result uses concentrate with local based ingredient and rice brand to BWG of Sumba Ongole’s broodstock cattle and calf (figure 1 and figure 2).
Based on figure 1, the average value of BWG is high on the broodstock cattle fed by concentrate treatment when it is compared with the rice bran treatment. The result is consistent with a high content of Crude Fiber (36%), low in-vitro DM digestibility (25%), and also low in-vitro OM digestibility (27%). Based on the analysis of covariance, both treatments and initial BW of Broodstock cattle are not significantly different with BWG of Broodstock cattle (P>0.05). The highest average of BWG on concentrate treatment is probably caused by the ingredients, which are cassava, river tamarind leaves, and Gliricidae leaves. Those ingredients have higher OM digestibility (33% to 65%) comparing with rice bran, which has OM digestibility of only 25% (table 2).

The high content of OM inside the concentrate will be fermented into propionic acid, which will transform into carbohydrate. Care and Barlet (1995) stated that the quantity and biological value of feed consumed become factors affecting BWG. If the feed given is already above the basic life necessities, especially for protein and energy, it can improve cattle productivity.

The growth is the sum of body mass in a certain period, which is very specific to the livestock commodity. The growth of a pre-weaning calf is affected by genetic factors, birth weight, total calf each partus, and also the cow’s age. The variation of calf’s growth happens because of genetic factors, rearing management, and the quality of feed.

The average body weight gain of the Ongole calf consuming local concentrate and rice bran can be seen in figure 2.
Based on figure 2, the average of BWG Ongole calf in concentrate treatment is higher than rice bran treatment. The condition is consistent in CP of concentrate (12.1%) comparing with rice bran (5.6%). The average BWG Ongole calf in concentrate treatment reaches the maximum at the fourth and fifth week, and then it tends to be stable at the sixth to eighth week. Based on the analysis of covariant, the treatment has a very significant effect on the BWG calf ($P<0.01$). However, the initial BW has no significant effect on the BWG calf ($P>0.05$).

Care dan Barlet [20] interpreted that the growth pattern has two phases: (1) accelerating phase; and (2) decelerating phase. The accelerating phase happens before maturity in sexuality, which is indicated by high-speed body growth. The Deceleration phase is marked by the slowing down of body weight growth until it reaches a stable position. As the point, the growth is series of processes which happens in the regular cattle’s life, including consistent BWG until it reaches the fully mature cattle (growth), carcass transformation, and also body composition due to the different growth velocity for each body component (development).

4. Conclusions
The conclusion of the study is the ingredients of concentrate, especially cassava and milled corn, has high in DM digestibility, OM digestibility, and TDN compared with other ingredients. It is also due to the lower content of CF in cassava and milled corn when compared with rice bran. The average of BWG in Broodstock Cattle fed with concentrate is higher than rice bran, which is consistent with higher CF (36%), and low in-vitro digestibility of both DM (25%) and OM (27%) in rice bran. The average of BWG Ongole calf in concentrate treatment is higher than rice bran, which is consistent in concentrate's CP (12.1%) than rice bran (5.6%). In order to improve the productivity of Sumba Ongole Cattle, the local base concentrate is recommended. However, the presence of rice bran cannot be ignored due to its ability to repair BWG and also create high DM, OM, and also TDN.

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