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Research Article

# Seasonal Forage Availability, Nutrient Composition and Mineral Concentrations of Imported Breed Cattle at the Padang Mangatas Breeding Center for Beef Cattle in West Sumatra, Indonesia

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## Abstract

**Background and Objective:** Grazing pasture is presumably able to fulfill fodder requirement for a greater population of breeding cattle, whereas low reproductive rates are most likely caused by mineral deficiency in soil and grazing forages. The present study aimed to evaluate seasonal availability and nutrient composition of pastures in relation to carrying capacity and mineral concentrations of imported breed cattle by considering the mineral profiles of soils, forages and blood plasma samples. **Materials and Methods:** Samples of forage and soils were collected from 75 sampling points at 15 pasture paddocks during wet and dry seasons. Sample of forages were used for estimation of botanical composition of planted forage species, biomass production and carrying capacity and then analyzed for Dry Matter (DM), crude nutrient, fiber fraction and minerals (Ca, P, Mg, Fe, Mn, Cu, Se and Zn) the same minerals were also analyzed in soil samples. Blood samples were collected from 15 female Simmentals, including heifers and pregnant and non-pregnant cows of each 5 animals. Blood plasma samples were analyzed for Ca, P, Mg, Fe, Mn, Cu, Se and Zn. **Results:** Pastures were dominated by the *Brachiaria decumbens* species of approximately 81-84%, while legumes were scarce (0.1-03%). Biomass production carrying capacity and fiber content of forages were significantly higher in the wet season, while DM and crude protein contents were higher in the dry season. Minerals of forages were not significantly affected by the seasons, some micro minerals Mn, Se, Cu and Zn were deficient in soil, forages and cattle. **Conclusion:** The stocking rate of the grazing pasture could be increased and that dietary supplementation of micro minerals (Mn, Cu, Se and Zn) is needed.

Key words: Tropical forage, minerals, beef cattle nutrition, dry matter, mineral concentration

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Beef cattle production in West Sumatra is dominated by small-scale farm enterprises and has shifted from local to exotic breeds, especially crossed-bred Simmental[1]. However, this effort to increase revenue was hampered by the expensive price of the exotic breed with the price of young Simmental bull 12-13 months of IDR 12-14 million, sold for IDR 18-20 millions after 12 months of fattening, producing an average income of approximately IDR 500.000 month$^{-1}$. The price of local cattle breed, such as Bali cattle and cross-bred Ongole (PO) is only IDR 6-8 million, with a doubled fattening period needed to achieve the same income as the Simmental breed[2].

Local government seeks to increase the supply of affordable exotic breed stock by optimizing production capacity of the Padang Mangatas breeding center for beef cattle located in Payakumbuh region of West Sumatra, Indonesia. The breeding center which covers approximately 280 ha areas is a national livestock development center that has special functions to produce exotic cattle stock with higher body size and meat-carcass portion, resulting in better growth performance than local beef breeds. The breeding center raises imported pure breeds of Simmental and Limousine to produce exotic breed stocks that are adaptable to local rearing management under tropical conditions.

In addition to the limited population, productivity of imported breed at the Padang Mangatas breeding center is also constrained by the low reproductive rate of cows due to various reproductive disorders, such as silent heat periods, delayed conception, poor fertilization and postpartum infertility. The average age of sexual maturity and first calving is achieved at the ages of 18 and 30 months, respectively, while in the origin country of Australia, it is at 13 and 24 months, respectively[3]. A calving interval of approximately 18 months is much longer than that in Australia of 13-15 months[4]. Calves are born with low birth weight and weak, so that the mortality rate of calves is 20%, while in Australia it is only 16%[5].

Feed offered provided to cattle is foraging by allowing the animals to graze at 40 pasture paddocks covering the total area of 208 ha. Grazing pasture is presumably able to fulfill fodder requirement for a greater population of breeding cattle, whereas low reproductive rates are most likely caused by mineral deficiency in soil and grazing forages. Several incidents of mineral inadequacies in forages and soils have been reported, which are principal causes of reproductive failure of imported dairy cattle in tropical countries[6-8]. Mineral deficiencies in grazing animals are specific to certain regions and are directly related to soil characteristics[9,10]. Mineral in forages are dependent upon the interaction of a number of factors, including soil, plant species, stage of maturity, yield, pasture management and climate[11].

Mineral deficiencies likely to affect production of grazing livestock on pastures in most of the world regions include those of the major elements (Ca, P and Mg) and the trace elements (Cu, Mn, Se and Zn)[11-13]. Deficiencies in Ca, P, Mn, Cu, Zn and Se in forages and grazing cattle have been reported by Prabowo *et al.*[14,15] in South Sulawesi of Indonesia. Khalil *et al.*[1] found that some essential minerals (Ca, P, Zn, Cu and Se) are located in marginal concentrations in wild forage in West Sumatra. These nutrients play a critical role in physiological processes related to health, growth and reproduction and the adequate function of the immune and endocrine systems[16,17], thus, adequate nutrition of minerals could encourage the imported heavy-breed types to reach their genetic potential, alleviate the negative effects of a harsh physical environment and minimize the effects of poor management techniques.

The purpose of the present study was to appraise carrying capacity based on biomass production and crude nutrient composition of grazing during different seasons and to define the mineral status of grazing cattle by evaluating the mineral profiles of soils, forages and blood plasma samples. This information could better inform pasture usage and management to make more precise recommendations for the preparation of feed supplements for the improvement of the growth, reproduction performance and health of imported breeding cattle raised under tropical conditions.

## MATERIALS AND METHODS

**Sampling and analysis nutrients and minerals of forages and soils:** Samples of forages and soils were collected at 75 sampling points during the wet (February) and dry (August) seasons of 2016 at the Padang Mangatas Beef Cattle Breeding Center in that Payakumbuh region of West Sumatra, Indonesia. Mean rainfall of about 274 and 89 mm month$^{-1}$ was recorded during the wet (November-May) and dry seasons (June-October), respectively. Sampling points were located at 15 paddocks which were distributed across three different topographies of slope, undulating and hilly. The selected paddocks were as follows: XX, XVIIIB, XVIIB, XV T, XIV, II, XVI, XVB, XIIIB, XIIIT, B, XIIA, E, DB and DT (Fig. 1).

At each selected paddock were determined 5 sampling points by dividing the paddock areas proportionally into 5 blocks by considering land contour, plant condition and accessibility. Samples of forages were collected using

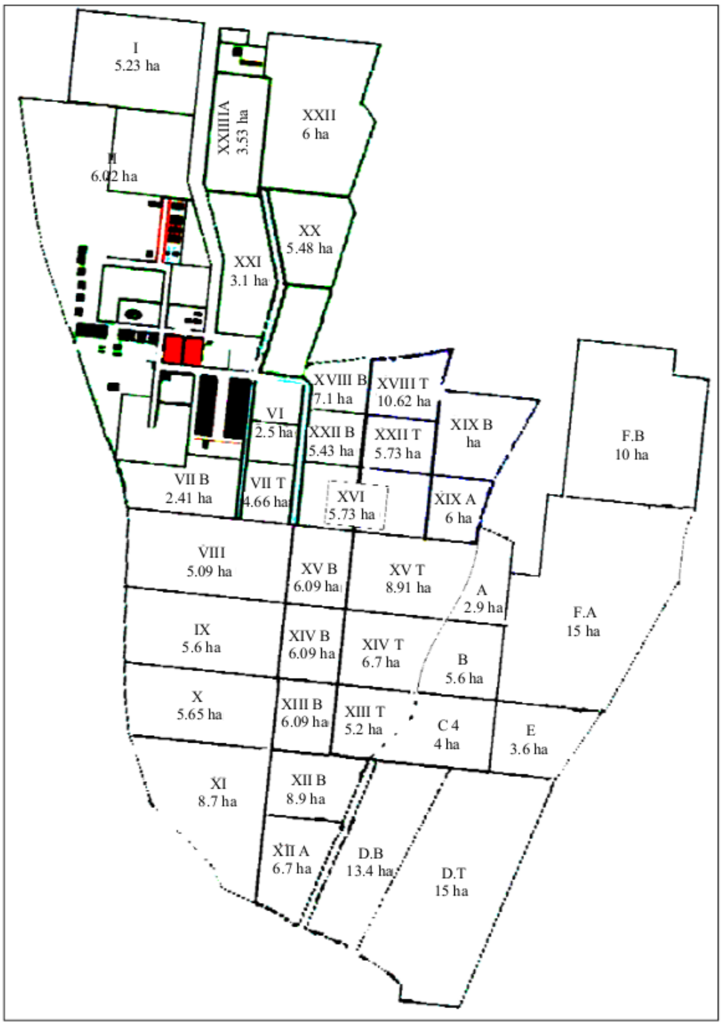


Fig. 1: Sampling sites at the Padang Mangates Breeding Center for Beef Cattle

quadrants plate mater of 0.5×0.5 m in size according to Khalil *et al.*[1] for estimation of forage availability. Plate meter was randomly placed at each sampling points. Plant materials in plate meter were cut above ground level of about 5-10 cm and placed in individual plastic bag. Fresh samples were weighed and then separated into species for determination of botanical composition. All samples in the same paddock were then chopped and mixed together. Representative samples of approximately 150 g were dried in a oven at 60°C for 48 h and ground in meal form prior to analysis for Dry Matter (DM), crude ash, Crude Protein (CP), Crude Fiber (CF), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), cellulose and minerals (Ca, P, Mg, Fe, Mn Cu, Se and Zn).

Soil samples were taken from the same sampling points from which the forage samples were taken. The soil sampling technique used in this study was described by Bahia[18]. Soil samples of approximately 500 g were obtained using a stainless steel sampling auger to a depth of 15-20 cm. The fresh samples freed from plant roots and other foreign contaminants and their particle sizes were reduced and uniformed by manual grinding using a glass bottle. Representative samples of approximately 1000 g were then dried in an oven at 60°C for 48 h and subsequently ground and stored in plastic whirl pack sample bags until analysis. The samples were analyzed for DM and minerals (Ca, P, Mg, Fe, Mn, Cu, Se and Zn).

The DM and nutrient contents of crude ash, CP and CF of forages were determined using proximate procedures[19]. Fiber fraction of NDF, ADF and cellulose were prepared according to Goering and Van Soest[20]. Samples of forages for mineral analysis were prepared by a wet digestion method using concentrated sulfuric acid and hydrogen peroxide, while soil samples were extracted using Mehlich-1method (0.05 M HCl+0.0125 M $H_2SO_4$) following by Rhue and Kidder[21] in the Chemical Laboratory of the Soil Department of Andalas University. The mineral concentration of Ca, P, Mg, Fe, Mn, Cu, Se and Zn were determined using the atomic absorption spectrophotometer[22]. All analysis results were reported on DM basis.

**Sampling and analysis of blood plasma:** Samples of blood were collected from 15 female Simmental breed cattle, including heifers and pregnant and non-pregnant cows of each (5 animals). Pregnancy status was determined by cows who were not pregnant for a long period of time after repeatedly artificial insemination. The average body weight of heifers and cows was about 651±41.8 kg, respectively, the average age was between 3.5-5.5 years.

Blood samples were collected from the tail vein (v. coccygica) using 10 mL disposable syringes. Blood was then transferred to heparinized vials in order to avoid the clotting and samples were centrifuged at 3000 rpm for 20 min to separate plasma which was then preserved under refrigeration until mineral analysis.

Mineral concentrations of Ca, Mg, P, Fe, Cu, Zn Se and Mn in the plasma were determined by standard methods by using the atomic absorption spectrophotometer at the Chemical Laboratory of National Veterinary Service Institute in Baso, Bukittinggi, West Sumatra, Indonesia.

**Statistical analysis:** Data obtained in the present study were statistically analyzed by using variance analysis (ANOVA). Data on botanical composition, biomass production, carrying capacity, nutrient and mineral content of forages were analyzed using a completely random design of 2×15 consisting of 2 seasons and 15 sampling paddocks as replicates, while data on mineral concentration of blood plasma were analyzed with 3 different statues of cow reproduction and 5 animals each as replicates. Duncan's Multiple Range Test (DMRT) was applied to separate means. Differences were considered[23] significant at $p<0.05$. Correlations of mineral concentrations in soils, forages and blood plasma were established using statistical software[24].

## RESULTS AND DISCUSSION

**Productivity and quality of pastures:** Grazing pastures in the Padang Mangatas breeding center for beef cattle are dominated by *Brachiaria decumbens* which account for 81-84%, followed by star grass (*Cynodon plectostachyus)* (4-13%) and *Panicum maximum* (1.7-4.6%). The percentage of star grass was significantly higher in the dry season than in the wet season, while *P. maximum* tended to grow more in the wet season than in the dry season. Pastures were also mixed with legumes of *Centrocema pubescens* and *Stylosanthes guyanensis* but were found to be scarce (Table 1).

There was a significant seasonal difference in biomass production, carrying capacity and the content of DM, CP and fiber. Biomass production of DM during the wet season was significantly ($p<0.01$) higher than in dry season. Consequently, the carrying capacity of pasture during the wet season was significantly higher than in the dry season (Table 1). Even though biomass production and carrying capacity was limited during the dry season (with total pasture areas of 208 ha, the current population of imported breeds of 712 animals and the average body weight of the present imported heavy-breed types of approximately 650 kg animal$^{-1}$), grazing pastures fulfilled forages requirement for approximately 1,300 AU

Table 1: Botanical composition, biomass production, carrying capacity and crude nutrient content of pastures in two different seasons

| Parameter | Rainy season | Dry season |
|---|---|---|
| **Botanical composition (%)** | | |
| *Brachiaria decumbens* | 83.95 (21.68)* | 81.33 (21.00) |
| *Cynodon plectostachyus* | 4.03 (1.04)$^{b}$ | 13.43 (3.50)$^{a}$ |
| *Panicum maximum* | 4.61 (1.19) | 1.74 (0.45) |
| *Centrocema pubescens* | 0.35 (0.09) | 0.08 (0.02) |
| *Stylosantes guyanensis* | 0.31 (0.08) | 0.05 (0.01) |
| Weeds | 6.75 (1.74)$^{a}$ | 3.37 (0.87)$^{b}$ |
| Total | 100.00 | 100.00 |
| **Biomass production and carrying capacity** | | |
| Biomass production (kg DM ha$^{-1}$ year$^{-1}$) | 42,596.32$^{a}$ (2874.46) | 26,538.32$^{b}$ (2313.39) |
| Carrying capacity (AU ha$^{-1}$) | 11.38 (0.78)$^{a}$ | 6.33 (0.49)$^{b}$ |
| **DM, crude nutrient and fiber composition (%)** | | |
| DM (FW%)** | 20.68 (0.57)$^{b}$ | 26.01 (0.79)$^{a}$ |
| CP | 9.24 (0.82)$^{b}$ | 11.50 (0.91)$^{a}$ |
| Crude ash | 10.47 (0.31) | 9.42 (0.33) |
| CF | 33.26 (0.81)$^{a}$ | 27.73 (0.58)$^{b}$ |
| NDF | 75.62 (0.72)$^{a}$ | 69.35 (0.89)$^{b}$ |
| ADF | 46.63 (0.69)$^{a}$ | 38.66 (0.70)$^{b}$ |
| Cellulose | 33.62 (1.09) | 31.46 (0.58) |

*SEM: Standard error of means, **Fresh weigh, $^{a,b}$Values in the same column with different superscripts are significantly different ($p<0.05$)

during the dry season, such that the population of imported pure-breeds raised could increase from of 712 (926 AU) to about 965 (1,300 AU) animals in order to produce more exotic breed stock. It might also be possible to use forages more efficiently, as there was an excess in forage production during the wet season.

Pastures had significantly higher DM and CP content in the dry season than in the wet season, however, forages during the wet season had significantly higher content in crude fiber and cellulose in comparison to the dry season (Table 1). Although the quantity of legumes was limited, the CP content of the pasture forage of 9.2-11.5% in DM in the present study was found within range of the minimum standard requirement of CP requirement for breeding beef cattle (8-11%)[25].

**Mineral composition of soil, pastures and blood samples:** In Table 2 shows that, the mineral composition of pasture were similar across seasons and the differences were not statistically significant ($p>0.05$). Macro mineral concentrations of Ca, P and Mg in the forages were above the critical limit of the standard requirements according to McDowell[26] of 3.0, 2.5 and 1.0 g kg$^{-1}$ DM of Ca, P and Mg, respectively) (Table 2). The macro minerals Ca, P and Mg in the soil and forages were likely contributed by limes and fertilizers used for pasture maintenance.

Table 3 shows there were no significant differences in mineral concentrations in blood plasma collected from different reproduction statues of cattle. Considering the critical levels the blood for Ca (8.0 mg dL$^{-1}$), P (4.5 mg dL$^{-1}$) and Mg (2.0 mg dL$^{-1}$)[26], blood plasma Ca, P and Mg (Table 3) levels were within the normal range. In addition to the forages, animals were also supplemented with concentrated feed enriched with Ca and P sources. The adequate levels of Ca, P and Mg supported by Ca-P-Mg homeostasis[27] may explain the rare incidences of reproductive disorders related to deficiencies of these macro minerals, such as dystocia, retention of placenta, prolapse of uterus and embryonic death[28-30].

Ca content in the pasture was positively correlated with the Ca concentration in the soil (r = 0.1333) and blood plasma (r = 0.533), however, P and Mg content was found negatively correlated with P and Mg concentrations in the soils and blood plasma (Table 4). Shisia *et al.*[31] reported negative correlations of Ca in soil and forages (r = -0.002) and positive correlations of Mg in the soil and forages (r = 0.005) in natural and communal grazing areas in Kenya.

Fe content in forages during both seasons of approximately 56.3-58.2 mg kg$^{-1}$ DM was above the minimum standard requirement and sufficient for maintenance and production requirements of grazing ruminant livestock[25]. Positive correlations were found between Fe levels in the forages and Fe concentrations in the soils (r = 0.721) and blood plasma (r = 0.019). The average Fe concentrations in blood plasma (Table 3) reported to be above the critical level[26] of 1.1 mg L$^{-1}$. Fe deficiency is extremely rare in grazing adult cattle and because Fe is ubiquitous in the environment, there is usually adequate content in the soils and forages[9,31,32]. In Table 4, the soil contained very high Fe levels of

Table 2: Mineral composition of pastures in different seasons in comparison to critical levels

| Minerals | Rainy season | Dry season | Critical level* |
|---|---|---|---|
| **Macro minerals (g kg$^{-1}$ DM)** | | | |
| Ca | 5.56 (0.24) | 5.82 (0.30) | <3.0 |
| P | 8.68 (1.07) | 8.55 (0.57) | <2.5 |
| Mg | 1.52 (0.16) | 1.83 (0.04) | <1.0 |
| **Micro minerals (mg kg$^{-1}$ DM)** | | | |
| Fe | 56.29 (4.46) | 58.17 (4.57) | <30 |
| Mn | 34.37 (0.80) | 34.20 (0.85) | <40 |
| Se | 1.33 (0.04) | 1.37 (0.04) | <0.1 |
| Cu | 0.74 (0.02) | 0.63 (0.05) | 8 |
| Zn | 5.63 (0.17) | 4.86 (0.21) | 30 |

*Critical level suggested for cattle by McDowell[26]

Table 3: Mineral concentration of blood plasma from cattle with three different reproduction statues

| Minerals | Reproduction status of cattle: Heifer | Pregnant cows | Non-pregnant cows | Critical levels* |
|---|---|---|---|---|
| **Macro minerals (mg/100 mL)** | | | | |
| Ca | 9.94 (0.70) | 11.70 (0.40) | 9.88 (1.08) | <8.00 |
| P | 7.54 (0.71) | 7.96 (0.60) | 9.04 (1.85) | <4.50 |
| Mg | 2.14 (0.29) | 2.88 (0.25) | 2.60 (0.18) | <2.00 |
| **Micro minerals (ppm)** | | | | |
| Fe | 2.80 (0.07) | 3.14 (0.20) | 2.80 (0.16) | <1.10 |
| Mn | - | - | - | |
| Cu | - | - | - | <0.65 |
| Se | - | - | - | <0.03 |
| Zn | 2.38 (0.39) | 2.59 (0.43) | 2.58 (0.12) | <0.80 |

*Critical level suggested for cattle by McDowell[26], -: Not detected by standard concentration of 0.005 mg L$^{-1}$

Table 4: Correlation of minerals in soil, pasture and blood plasma

| | Mineral content | | | Coefficient correlation (r) | |
|---|---|---|---|---|---|
| Minerals | Soil (mg kg$^{-1}$ DM) | Pastures (mg kg$^{-1}$ DM) | Blood plasma (mg L$^{-1}$) | Soil/pasture (n = 15) | Pasture/blood (n = 15) |
| **Macro minerals** | | | | | |
| Ca | 6794.94 (97.83) | 5690.94 (198.9) | 105.07 (4.73) | 0.133 | 0.532 |
| P | 1993.89 (176.18) | 8614.81 (471.11) | 81.80 (6.60) | -0.716 | -0.303 |
| Mg | 129.60 (9.27) | 1673.52 (87.19) | 25.40 (1.54) | -0.593 | -0.157 |
| **Trace minerals** | | | | | |
| Fe | 20217.88 (1475.35) | 57.23 (4.51) | 2.91 (0.09) | 0.721 | 0.019 |
| Mn | 32.11 (1.26) | 34.28 (0.43) | nd* | 0.079 | - |
| Se | 1.23 (0.05) | 1.35 (0.04) | nd | 0.064 | - |
| Cu | 6.15 (0.56) | 0.69 (0.01) | nd | 0.360 | - |
| Zn | 17.54 (1.29) | 5.25 (0.14) | 2.52 (0.18) | 0.176 | -0.170 |

*Not detected by standard concentration of 0.005 mg L$^{-1}$

20217.9 mg kg$^{-1}$ DM or approximately 350 times the Fe content the forages (57.2 mg kg$^{-1}$ DM). This finding was supported by similar reports in Pakistan of about 20-100 times the Fe content found in pastures[11]. Iron (Fe) plays a major role in the transport of oxygen through hemoglobin in the blood and myoglobin in skeletal muscles. Iron is also an integral part of cytochromes and Fe-dependent proteins involved in electron transport, as well as constituent of a number of Fe-activated enzymes[33,34].

Although Se concentration in the forage was above the CL standard requirement for grazing cattle of 0.10 mg kg$^{-1}$ DM[26], forage Se concentration was not sufficient, because Se concentration in blood plasma not detected using a standard concentration of 0.005 mg L$^{-1}$. According to MacDowell[26] the critical level of Se in the blood is 0.03 ppm. The importance of Se in cattle reproduction has been reviewed by Smith and Akinbamijo[35]. Selenium is an anti-oxidant that works in conjunction with vitamin E to prevent and repair cellular damage in the body. Selenium and/or vitamin E deficiency has been shown to impair the immune response. In addition, Se is associated with the thyroid hormone that regulates metabolism, reproduction, circulation and muscle function. Selenium can be transferred through the placenta and milk; therefore, selenium status of the cows can directly affect the health of their calves. Selenium deficiency is associated with delayed conception rate and cystic ovaries in dairy cows[12,36].

Limited Se levels in forages and blood plasma in the present study may explain the poor reproductive performance in grazing animals at the Padang Mangatas breeding center, as Se deficiencies may directly impair ovarian activities and can cause several reproductive disorders, such as silent heat periods, delayed conception, poor fertilization and postpartum infertility[35].

Manganese levels in forages of approximately 34.2-34.4 mg kg$^{-1}$ DM were slightly lower than the standard requirement of 40 mg kg$^{-1}$ DM[25]. Manganese concentration in the soils of 32.1 ppm which was many folds higher than the minimum critical level (<1.0 ppm)[37] was positively correlated (r = 0.079) with Mn concentration within the forages (34.3 ppm) (Table 4). However, Mn levels in blood plasma were not detected in comparison to standard concentration of 0.005 mg L$^{-1}$ (Table 3). This finding may be due to solubility, as Mn solubility is very sensitive to change in soil pH[38]. Manganese is an integral component of several enzymes, such as arginase, superoxide dismutase (found in mitochondria) and pyruvate carboxylase[39-41]. In females, Mn functions to properly regulate synthesis of ovarian hormones[42]. Signs of manganese deficiencies include poor growth and skeletal deformities in newborn calves and reproductive abnormalities, including anestrus, in adult cows[31]. Dietary Mn concentrations of 50 mg kg$^{-1}$ are recommended for normal fetal development[41,43].

Copper was detected in critical concentrations in the soil, forages and blood plasma. Copper levels in the pasture of approximately 0.63-0.74 mg kg$^{-1}$ DM were extremely low compared to the critical levels in the diet of 10 mg kg$^{-1}$ DM[25,26]. Low Cu concentration in the soil and forages were reflected in the blood samples of the animals. Copper levels in the blood plasma could not be detected in comparison to standard concentrations of 0.005 mg L$^{-1}$, the critical levels of Cu in the blood are 0.65 ppm[26]. Copper is an important mineral for reproduction and Cu deficiency is responsible for early embryonic death and resorption of the embryo, increased chances of retained placenta and necrosis of placenta and low fertility associated with delayed or depressed estrus[28].

Despite relatively high concentrations in the soil of 17.5 mg kg$^{-1}$ DM, Zn levels in forages were detected at very low concentrations of 4.9-5.6 mg kg$^{-1}$ DM in comparison to the critical levels of Zn in the diet of 30 mg kg$^{-1}$ DM[25,26]. Soil acidity is likely the main factor for micro mineral deficiencies in forage and blood. At a soil pH below 6.5, the availability of Mn, Cu and Zn is reduced[11,31]. The values of Zn concentration in the blood plasma of 2.38-2.59 ppm were much higher than the critical level of Zn in the blood (0.80 ppm)[26]. Correlation analyses indicated a negative correlation between Zn levels in pasture and in blood plasma (r = -0.170) (Table 4). The Cu and Zn deficiencies in the soil, forages and blood samples of grazing cows in Pakistan were reported by Khan *et al.*[44]. Marginal deficiencies of Cu, Zn and Mn were also observed in grazing cattle and below the critical level in South Sulawesi in Indonesia[45].

Zinc is essential for proper sexual maturity (development of secondary sexual characteristics), reproductive capacity (development of gonadal cells) in males and all reproductive events (estrus, pregnancy and lactation) and with the onset of estrus in female[28]. Zinc also plays a critical role in the repair and maintenance of the uterine lining following parturition and early return to normal reproductive function and estrus[46]. The Cu and Zn are required to prevent anestrus[42,47]. In males, Zn deficiency can lead to delayed puberty and under-developed testes[48].

## CONCLUSION

The grazing pastures at the Padang Mangatas Beef Cattle Breeding Center showed higher biomass production and fiber content during the wet season. Forage availability was significantly decreased in the dry season, however, the available biomass with higher crude protein still exceeded the DM requirement of current stocking rate. The mineral composition of pastures tended to be similar regardless of season. Some trace elements (Mn, Se, Cu and Zn) were deficient in soil, forages and cattle, indicating that the stocking rate of the grazing pasture could be increased and that dietary supplementation of micro minerals (Mn, Cu, Se and Zn) are needed to ensure reproduction performances and to improve the production capacity at the breeding center.

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