Weaning weight of Brahman cross (BX) and Bali cattle under intensive and oil palm plantation-cattle integrated systems

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Abstract. Indonesian territory comprised of a vast archipelago with diverse environmental condition affects cattle’s growth and productivity. This paper was aimed to compare the weaning weight (WW) of two genotype groups of cattle (Bali and BX) under different production systems. Data were obtained from oil palm plantation cattle integrated system (OPP) in Central Kalimantan (972 BX, 131 Bali), an intensive cattle farm in Java Island (15 BX) and a state’s breeding farm in Bali Island (322 Bali). We visualize the distribution of WW from both breeds and analyse the interaction between genotype groups and production systems. Data visualization revealed structures underlying the dataset, we observed that Bali cattle data were clustered into two distinct groups. Least squared means and standard deviation of WW in Bali cattle were 84.26±17.29 and 169±74 kg whereas for BX were 121±32 and 174.28 kg for farm and OPP production systems respectively. Results from a linear model which showed that genotype group, production systems, sex, and two ways interactions between genotype group and production system had a significant effect on WW (α = 0.05). In their respective farm production systems, BX performed significantly better than Bali cattle. However, in OPP-production system both genotype groups had similar performance.

1. Introduction
Human population in Indonesia has been increasing significantly and as a consequence, the demand for food, including beef meat has also increased. However, there is always a gap between supply and demand of beef meat, since the domestic production can only satisfy about 45% of Indonesian demand for beef. In response to the increasing demand for beef meat [1]. Indonesian’s government has been importing meat as well as live feeder and slaughter stocks, a few breeding animals and semen [2]. Brahman cross is the most preferred imported cattle from Australia.

Brahman Cross is mix-crossed between Hereford-Shorthorn (Bos Taurus type) and Brahman (Bos Indicus (Zebu) type), in Australia. Brahman Cross is commonly selected for growth rate and resistance to external parasites, but not for body color [3]. Brahman Cross has commercial trade name as Australian Commercial Cross (ACC), which has been developed in Northern Territory, Kimberly and Queensland, Australia. Brahman Cross are commonly exported to Indonesia as feeder stocks and fattened for 3-4 months by feedlot companies. Given Indonesia’s government recently implemented a regulation for feedlot companies to import productive female cattle from Australia, new challenges for the companies are existing since maintaining breeding stocks is more critical than fattening ones.
To resulting an efficient production cost, integrating cattle breeding stocks with oil palm plantation becomes an option for production systems. This study is aimed to compare the weaning weight of Brahman cross and Bali cattle, an adaptive indigenous breed, under oil palm plantation (OPP) and intensive farming systems.

2. Material and methods

2.1. Material
Central Kalimantan, Central Java, and Bali were used for data collection. In total 972 heads of Brahman cross and 131 heads of Bali cattle in an extensive OPP system in Central Kalimantan; 15 heads of Brahman cross in an intensive farm in Java and 322 heads of Bali cattle in an intensive breeding center in Bali were observed. Observation and records were made individually for weaning weight (WW) trait standardized for 205 days. We separated the cattle into two groups based on breeds (Brahman cross and Bali) and production system (OPP and intensive). The data were collected for approximately two years (2016-2017) in each location.

2.2. Methods
A density plot for WW trait with Gaussian kernel smoothing was built to visualize the distribution underlying the dataset. Later we estimate the effect of breed, production system and sex on WW $(\alpha=0.05)$ with the following model:

$$y_{ijkl} = \mu + B_i + PS_j + S_{k(l)} + B*PS_{ij} + \epsilon_{ijkl}$$

where $y$ is the observed variable of WW, $\mu$ is general mean, $B_i$ is the effect of breed ($i = 1, 2$), $PS_j$ is the effect of production system ($j = 1, 2$), $S_{k(l)}$ is the effect of different sexes ($k = 1, 2$) nested within each breed, $B*PS_{ij}$ is the interaction term between breed and production system whereas $\epsilon$ is the random residual term. When the factor(s) showed a significant difference, Tukey’s pairwise analysis was conducted as the post-hoc procedure.

3. Results and discussion
The structure underlying the dataset in our study is presented in Figure 1. There was a single peak within Brahman cross dataset; whereas there were two peaks within Bali cattle datasets, which means that this data was divided into two clusters based on the production system. Bali cattle in OPP system was better than one in the intensive system.

Figure 1. Density plot of Weaning weight
Summary statistics of WW are presented in Table 1. BX is significantly heavier than Bali cattle at wean (confirming Figure 1). Cattle in OPP were heavier at wean compared to cattle in an intensive production system. This discovery is consistent with the analysis result on the interaction between breed and production system. Cattle in OPP were consistently heavier than cattle within an intensive production system, this applied for both breeds. Male cattle were heavier than female cattle in both breeds. However, both male and female BX were heavier than Bali cattle.

Table 1. Summary statistics of the cattle’s weaning weight (Kg)

| Factors                  | n   | Mean±SD (Kg) |
|--------------------------|-----|--------------|
| Breed                    |     |              |
| BX                       | 987 | 173.48±28.74a|
| Bali                     | 987 | 107.61±42.28b|
| Prod. System             |     |              |
| OPP                      | 1093| 173.78±27.26a|
| Intensive                | 337 | 85.91±19.73b |
| Sex (Breed)              |     |              |
| Male (BX)                | 506 | 175.39±30.00a|
| Male (Bali)              | 247 | 114.00±44.73b|
| Female (BX)              | 481 | 171.46±27.23a|
| Female (Bali)            | 196 | 99.55±37.56c |
| Breed*Prod. System       |     |              |
| BX_OPP                   | 972 | 174.28±20.74a|
| BX, intensive            | 15  | 121.32±32.87b|
| Bali_OPP                 | 121 | 169.73±20.74a|
| Bali, intensive          | 322 | 84.26±17.29c |

Figure 2. Interaction plot between breeds and production systems

Figure 2. indicates that Brahman cross growth excelled Bali cattle in both environments. However, Bali cattle in OPP performed remarkably better than the ones in the intensive farms. The integration of cattle in oil palm is a form of mixed farming where the combinations of the two commodities can be synergized in order to optimally utilize the same piece of land. The two commodities, when properly integrated can contribute towards sustainable food production system. They are 60 to 70 species of
undergrowth under oil palm plantation consisting of planted leguminous cover crop, naturally growing grasses, broad leaves, and ferns, which are potential feeds source as the yields, palatability, and nutritive values are adequate for cattle [4]. Palm oil by products, such as palm kernel cake, oil palm fronds, and palm press fibre are also important to feed sources [5].

4. Conclusion
In the respective farm production systems, BX performed significantly better than Bali cattle. However, in OPP-production system both genotype groups had similar performance. Cattle integrated with OPP is a potential system to develop in Indonesia. A systematic approach and implementation become a successful key in the cattle integration in OPP.

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