Growth responses of maize-soybean intercropping system and its potential for cattle feed in Bali

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Abstract. There had been a 2.145 ha fields transition in Bali which had a major impact on the loss of food production. However, there was raise in the population annually, therefore it disrupts local food security. Effort to raise the effectiveness and agricultural productivity areas through changing cropping system from monoculture to intercropping. This study aimed to find out the growth responses of maize and soybean crops cultivated by monoculture and intercropping planting systems and its carrying capacity for cattle feed. The study was arranged using a randomized block design with 3 treatments and 3 replications, namely: T1: Bima 20 URI VUB maize seeds in monoculture (40cm x 20cm x 80cm; 1 seed/hole or 70cm x 40cm x 100cm; 2 seeds/hole); T2: Anjasmoro, Deja 2 and Devon soybean VUB seeds in monoculture system (40cm x 20cm; 2-3 seeds/hole); T3: maize-soybean intercropping; Maize (2 rows; 40cm x 12.5; 2 seeds/hole); Soybeans (4 rows; 30cm x 10cm; 2-3 seeds/hole); both distance: 40cm. Data collected were growth performance, yield components and yield capacity of both maize and soybean crops also competition and profit value of maize and soybeans crops cultivated by intercropping planting system. The results showed that monoculture maize crops cultivated by monoculture planting system were better than it intercropped with soybean crops in terms of growth parameters. However, intercropping maize and soybean were produced greater yield components on cobs number, cobs and grains weight than monoculture (P<0.05), except grains weight per cobs. The monoculture soybean plant in growth, components and yield parameters were greater than intercropping (P>0.05). The ATER, LER, RCC, CR, and AYL values were 3.24; 1.28; -2.69; 4.58; -0.098 on maize and 2.52; 0.84; 1.82; 0.21; -0.158 on soybean. Those result was followed by carrying capacity in intercropping system by 30% usage can be used for 1.804 AU meanwhile 40% usage was sufficient for 1.353 AU. Intercropping system can be recommended to farmers to increase growth responses of maize-soybean and its potential carrying capacity for cattle feed.

1. Introduction
The Indonesian government has started to take a local food diversification policy to decrease people's dependence on rice as the staple food [1]. Local foods were cultivated as regional’s potential resources and practice therefore the varieties, quantities, and qualities rely on its specific area. It was spread across the Indonesian archipelago, namely maize, ganyong, garut, uwi, gadung, gembili and cassava [2]. Local food utilization was considered well-suited because of its abundant availability and simple-develop in
the local area [3]. In terms of the functional properties of food, it had similar competitiveness as rice, such as maize [4]. Maize was considered as potential commodities as an alternative staple food resource because of its nutritional content, mainly carbohydrates and protein which similar to rice and its production was abundant enough. Furthermore, the people were used to consume it because the supported of a relatively easy processing process [5].

Buleleng Regency was greatly comparative and competitive on maize commodities [6]. Buleleng was able to provide the main contribution to maize production in Bali Province. In Sukasada and Tejakula sub-districts, people utilized a maize as their daily staple food by processing it to “moran rice” which made from rice mixed with tubers and maize [7]. This condition indirectly required abundant maize production in this area which had a challenge of agroecological limitations as a marginal area and un-optimal farming system technical by local farmers.

In addition to the problem of agroecological limitations and un-optimal farming system technical, another problem was the widespread agricultural areas transition in Bali. Bali province relies greatly on the tourism sector to achieve great economic growth because the natural beauty attractiveness and all its cultural tourism could attract domestic and foreign tourists [8]. Bali also has a unique attractiveness in its agricultural sector, namely the Subak system which has become a world cultural heritage [8]. Subak was a traditional water-using farmers organization in Bali that was socio agricultural religious which was well-known globally and considered the highly sophisticated [9]. Nowadays, subak run into massive agricultural transition area that occurs annually, which greatly affects the Subak sustainability and local food security in Bali. Subak Bali was one of the main contributors in maintaining national food security through local food security without ignoring the local wisdom.

Based on the Research and Development Agency of Bali Province Data in 2016, there had been a 2.145 ha rice fields transition in Bali which had a major impact on the loss of food production, mainly rice. However, there was raise in the population annually, therefore it disrupts local food security [9]. Either absolute requirement for realizing food security and Subak sustainability in Bali was the availability of food agricultural area and concrete efforts to maintain the agricultural area availability sustainability [10]. Either effort to achieve this was to raise the effectiveness and agricultural productivity areas through changing cropping system from monoculture to intercropping. Various studies reported that intercropping was more beneficial than monoculture [11][12][13][14]. Soybean-Maize intercropping was greatly recommended by agronomists related to the crop’s nitrogen fixation ability [15]. Comparative analysis of various intercropping crops shows that soybean crops was greater in the intercropping system with maize. These two commodities can complement each other because both thermophilic crops by equal growing seasons [16]. Soybean crops were classified as shade tolerant legumes and form root nodules that were able to fix nitrogen through symbiosis with Rhizobium sp. and maize required direct lighting and high N amounts [17].

Furthermore, economic yields in the grains form, maize and soybean waste were greatly potential to farmers for using as cattle feed. In addition to economic yields in the form of seeds, maize and soybean waste is very useful for farmers to be used as cattle feed. In general, farmer almost relies on the feed availability from the nature, therefore, was often feed shortage in the dry season. In these conditions, agricultural waste such as maize and soybean stover becomes farmers relies on cattle feed adequacy. Based on these problems, study of the maize intercropping system and soybeans in Bali Province aimed to find out the growth responses of maize and soybean crops cultivated by monoculture and intercropping planting systems and its carrying capacity for cattle feed.

2. Materials and methods

2.1. Research design
The study of maize and soybean crops cultivated by intercropping planting system was carried out in Jembrana, Klungkung and Buleleng Regency, Bali Provinces in 2019 in 4-7 ha, respectively. The materials used were Bima 20 Uri maize VUB seeds, Anjasmoro, Deja 2 and Devon soybean VUB seeds.
The study was arranged using Block Randomized Design in three treatments and three replicated as described in Table 1.

Table 1. Maize and soybean crops cultivation in Bali Province in 2019.

| Technology Component | Treatment | Monoculture Maize (T1) | Monoculture Soybean (T2) | Intercropping maize and soybean (T3) |
|----------------------|-----------|------------------------|--------------------------|--------------------------------------|
| Planting System      | Farmer’s habit way (manual traditionally planting) | Farmer’s habit way        | By using corn-planter modern tool. The area had never been planted with soybeans, soybean seeds were wetted by mixed water and Rhizobium sp. or could use enough soil that has been planted with beans to cover the soil surface. |
| Spacing and seeds number | a) 40cm x 20cm x 80cm; 1 seed/hole or b) 70cm x 40cm x 100cm; 2 seeds/hole | 40cm x 20cm; 2-3 seeds/hole | a) Maize (2 rows): 40cm x 12.5cm spacing; 2 seeds/hole; seed population 30 kg/Ha b) Soybeans (4 rows): spacing of 30cm x 10cm; 2-3 seeds/hole; Seed population 70 kg/Ha c) Distance in maize and soybeans: 40cm d) Soybean planting was done early with an interval of 2 weeks before maize planting. |
| Plant Density        | ±70,000 plants/Ha | 300,000 plants/Ha      | a) Maize: 100,000 plants/Ha b) Soybean: 300,000 plants/He |
| Fertilization Dosage | a) Compost: 2 tons/Ha b) Urea: 300 kg/Ha c) Phonska: 200 kg/Ha d) Compost spread when soil cultivation or at planting to cover planting holes e) Organic fertilizer was applied after planting by covering the maize planting hole | a) Compost: 2 tons/Ha b) Urea: 50 kg/Ha c) Phonska: 100 kg/Ha d) Compost spread when soil cultivation or at planting to cover planting holes e) Organic fertilizer was applied after planting by covering the maize planting hole |
| Fertilizing Time     | a) 10 DAP: 1/3 urea Dosage + all phonska fertilizer b) 35 DAP: 2/3 urea dose | a) 10 DAP: 1/3 urea dose + all phonska fertilizer b) 35 DAP: 2/3 urea dose |
|                      | a) 10 DAP: 1/3 urea Dosage + all phonska fertilizer b) 35 DAP: 2/3 urea dose |
|                      | a) 10 DAP: 1/3 urea Dosage + all phonska fertilizer b) 35 DAP: 2/3 urea dose |
Weed Management

| a) Systemic herbicides, 7-10 days before planting | a) Systemic herbicides, 7-10 days before planting |
| b) Subsequent weeding manually as needed | b) Subsequent weeding manually as needed |

Pest Control

IPC protocol or by herbicides pesticides

Harvesting

a) The hardened grain, formed 50% of black layer, and the husks had dried.
b) The cobs were dried: 14% moisture content

Maize-soybean intercropping cultivation spacing layout, as shown in figure 1.

![Intercropping spacing layout between maize and soybeans.](image)

2.2. Data collection

Each treatment had 3 subplots as replicates with a size of 2.5 m x 2.5 m. 10% (soybean) and 100% (maize) population plants in the subplots were selected randomly as samples. Data collected were growth performance (plant height, number of leaves per plant, cob length, number of rows per cob), yield components (number of cob per frame area sampling and per hectare; cob weight with husk and without husk), and yield capacity (cob weight with husk per frame area sampling and per hectare; cob weight without husk per frame area sampling and per hectare; grain weight per frame area sampling, per hectare, and per cob) on maize plants, and on soybean plant was growth performance (plant height; number of tillers and branches per clump; number of clump per frame area sampling) and yield components capacity (number of pod and grain per clump; grain weight; stover weight per frame area sampling and per hectare).
Competition and profit value of maize and soybeans crops cultivated by intercropping planting system were known according to:

a. **Land Equivalent Ratio (LER)** was a land efficiency illustration in the intercropping system by using this equation:

\[ \text{LER} = \frac{Y_{ab} \cdot Y_{ba}}{Y_{aa} \cdot Y_{bb}} \]

Note: \(Y_{ab}\) = intercropped maize yield; \(Y_{aa}\) = monoculture maize yield; \(Y_{ba}\) = intercropped soybean yield; \(Y_{bb}\) = monoculture soybean yield.

b. **Area Time Equivalent Ratio (ATER)** was a description of the land equivalence value based on planting and harvesting time. The longer a plant type was in the field, the smaller the yield in time terms. ATER following this equation:

\[ \text{ATER} = \frac{Y_{ab} \cdot A_{ab} \times T_{ab}}{Y_{aa} \cdot A_{aa} \times T_{aa}} + \frac{Y_{ba} \cdot A_{ba} \times T_{ba}}{Y_{bb} \cdot A_{bb} \times T_{bb}} \]

Note: \(Y_{ab}\) = intercropped maize yield; \(Y_{aa}\) = monoculture maize yield; \(Y_{ba}\) = intercropped soybean yield; \(Y_{bb}\) = monoculture soybean yield; \(A\) = land area; \(T\) = time required to harvest.

c. **Relative Crowding Coefficient (RCC)** was the density on a land unit at the same time and place and were able to provide optimum results for each type of intercropped plant. RCC following using this equation:

\[ \text{RCC}_{ab} = \frac{Y_{ab} \cdot Z_{ba}}{(Y_{aa} - Y_{ab}) \cdot Z_{ab}} \]

Note: \(Y_{ab}\) = intercropped maize yield; \(Y_{aa}\) = monoculture maize yield; \(Y_{ba}\) = intercropped soybean yield; \(Y_{bb}\) = monoculture soybean yield; \(Z_{ba}\) = soybean plant population in intercropping system; \(Z_{ab}\) = population of maize plants in intercropping system.

d. **Aggresivity (A)** was measurement the plants ability to compete in obtaining resources in an intercropping system, using this equation:

\[ A_{ab} = \frac{Y_{ab}}{Y_{aa} = Z_{ab}} \frac{Y_{ba}}{Y_{bb} - Z_{ba}} \]

Note: \(Y_{ab}\) = intercropped maize yield; \(Y_{aa}\) = monoculture maize yield; \(Y_{ba}\) = intercropped soybean yield; \(Y_{bb}\) = monoculture soybean yield; \(Z_{ba}\) = soybean plant population in intercropping system; \(Z_{ab}\) = population of maize plants in intercropping system.

e. **Competitive Ratio (CR)** was the individual LER ratio in each plant component by taking into account the plants proportion that had been planted in intercropping at the beginning of planting. The CR value following this equation:

\[ \text{CR} = \frac{Y_{ab} / Y_{aa} \times Z_{ab}}{Y_{ba} / Y_{bb} \times LER_{a} \times LER_{b} / Z_{ab}} \]

Note: \(Y_{ab}\) = intercropped maize yield; \(Y_{aa}\) = monoculture maize yield; \(Y_{ba}\) = intercropped soybean yield; \(Y_{bb}\) = monoculture soybean yield; \(Z_{ba}\) = soybean plant population in intercropping system; \(Z_{ab}\) = population of maize plants in intercropping system.

f. **Actual Yield Loss (AYL)** was the proportion of yield loss or gain of intercropping planted in intercropping when compared to each monoculture crops. Yield loss in the intercropping system
was caused by competition for nutrients required to provide plant life requirements. The AYL value following this equation:

\[
AYLab = \frac{(Yab/Xab)}{(Yaa/Xaa)} - 1
\]

Note: \(Yab\) = intercropped maize yield; \(Yaa\) = monoculture maize yield; \(Xab\) = maize plant population in intercropping system; \(Xaa\) = maize plant population in monoculture system.

2.3. Data analysis
The agronomy data was analysed using variance analysis (ANOVA) and LSD 5%. The carrying capacity of intercropping maize and soybean by following this equation:

\[
X = \frac{A}{B}
\]

Note: \(X\) = The carrying capacity of maize and soybean waste for cattle feed, \(A\) = The maize and soybean stover weight per Ha (kg) \(B\) = The cattle feed requirement per day (kg/cattle unit)

3. Results and discussion

3.1. Agronomy performance of maize crop
Table 2 showed that monoculture maize plants were grown significantly on plant height than in intercropping. The intercropping did not affect the number of leaves and rows per cob. The intercropping system was not able to encourage maize plants to produce greater cobs length than monoculture maize.

| Treatment                        | Plant height (cm) | Number of leaves per plant | Cob length (cm) | Number of rows per cob |
|----------------------------------|-------------------|----------------------------|-----------------|------------------------|
| Monoculture maize                | 278.66 b          | 14.00 a                    | 18.16 b         | 14.00 a                |
| Intercropping maize and soybeans | 214.33 a          | 13.00 a                    | 14.81 a         | 13.33 a                |

Note: the numbers in same column followed by the same letter were not significantly different based on the variance test at the 5% level.

| Treatment                        | Number of cobs | Number of cobs per Ha | Cobs weight with husk (g) | Cobs weight without husk (grams) |
|----------------------------------|----------------|-----------------------|---------------------------|----------------------------------|
| Monoculture maize                | 33 a           | 49733.33 a            | 216.66 a                  | 204.96 a                         |
| Intercropping maize with soybeans| 55 b           | 80333.33 b            | 258.00 b                  | 245.37 b                         |

Note: the numbers in same column followed by the same letter were not significantly different based on the variance test at the 5% level.
Table 3 described that the intercropping had a positive impact on all parameter components of maize yields. The number of cobs yield components in intercropping was significantly greater and had 22 (pieces) difference per frame area sampling. The cobs were also significantly greater than the cobs in monoculture maize although the cob weight in the difference of planting system treatments tended to be equal (Table 3).

Cobs and grain weight per frame area sampling in intercropping system of maize and soybeans was significantly greater than monoculture maize cultivation, meanwhile the weight turned to be equal when the maize cobs produced by both treatments were peeled from the husk. The weight of maize husks produced in intercropping system per frame area was 2.26 kg greater than the monoculture (Table 4) and reached ± 4 tons greater when converted to hectares. This was less profitable because it affects crop production as maize cobs were the main part harvested in maize plant [18]. On the other hand, maize husks were one of the maize crops waste or maize biomass which can be used as livestock feed source [19]. The results of [19] concluded that proper plant spacing results in better quality forage for livestock feed. The number of grains and rows per cob as well as the weight and length of the cob were more influenced by genetic factors than environmental factors that related to the quality and quantity of pollen at pollination, pollination frequency and compatibility among pollinated plants. When the tassel was wetness or dried, the pollination process become hampered [20].

Maize cob length was influenced by the transferring photosynthate process from leaves to grains as food reserve. The greater food reserves in grains can produce greater grains size and indirectly affect the cobs size and weight. Optimal photosynthate resulted in raised crop production, cob length and cob weight [21]. This study used same maize variety following by a monoculture maize cropping system using legowo spacing (40cm x 20cm x 80cm) which known to provide a balanced growth space for plants thereby reducing the competition occurrence for nutrients and water. This spacing able to raise interception of lighting and CO₂ that enters monoculture maize because of the blank space in the form of an elongated hallway, therefore raising plant metabolism and biosynthesis for optimal production [22]. Accordance by the results of this study where the number of rows per cob and the cob weight without husk per frame area (including when converted to hectares) tend to be equal when planted in monocultures or intercropping.

The intercropping system was able to stimulate the maize generative growth, resulting in maize kernels weighing approach 2 times greater than the monoculture cropping system (Table 4). The study results showed that intercropping system had more significant positive impact on maize during the generative phase. Maize and soybean plants in intercropping system extract soil nutrients from different soil depth profile due to the difference in the root reach both, thereby minimizing the competition occurrence for nutrient absorption [23]. In addition, the nitrogen abundance in the rhizosphere due to the nitrogen fixation symbiosis by legumes makes it an important intercropping maize growth stimulate on the growth phase [24].

| Treatment               | Cob Weight (Frame Area sampling) | Grain Weight |
|-------------------------|----------------------------------|--------------|
|                         | With husk (kg)                   | Per Ha (grams) |
|                         | With husk per Ha (tons/ha)       |               |
| Monoculture maize       | 9.22 a                           | 133.00 b      |
| Intercropping maize and | 12.32 b                          |               |
| soybeans               |                                  |               |

Note: the numbers in same column followed by the same letter were not significantly different based on the variance test at the 5% level.
3.2 Agronomy performance of soybean crops

Soybean vegetative growth tends to be equal when it was planted in monoculture or intercropping with maize (Table 5). The monoculture cropping system significantly produced more pods and grains than intercropping, it was also found in grains weight and stover weight produced (Table 6). The components and soybeans production in monocultures tend to be greater than in intercropping. It was presumably due to the major interspecific plant competition and the shade influence by maize plants which were higher than soybean plants. The shade reduces the photosynthesis rate of soybean plants which has an impact on reducing soybean production [23]. In addition, soybean planting which was 2 weeks earlier than maize planting in intercropping system could had an effect. When maize plants required a lot of nitrogen for cob formation at 7 weeks after planting, soybean plants were in the peak phase of pod filling at 9 weeks after planting so there was competition in the nitrogen absorption elements. The nitrogen transfer by legumes to maize plants occurs when maize plants were in the peak vegetative growth phase. [25] recommend planting legumes 2 weeks after planting maize based on the results of study on the difference planting time of maize and beans.

Table 5. soybean crops growth cultivated by monoculture and intercropping planting system with maize crops.

| Treatment               | Variable                  | Plant height (cm) | Number of tillers per clump (stem) | Number of branches per plant (piece) | Number of clumps per frame area (stems) |
|-------------------------|---------------------------|-------------------|-----------------------------------|-------------------------------------|----------------------------------------|
| Monoculture soybean     |                           | 58 a              | 3.33 a                            | 4.66 a                              | 156.33 a                               |
| Intercropping Soybean   |                           | 54 a              | 2.66 a                            | 4.33 a                              | 163.00 a                               |
| Intercropping Soybean   |                           |                   |                                   |                                     |                                        |

Note: the numbers in same column followed by the same letter were not significantly different based on the variance test at the 5% level.

Table 6. yield components and the yield of soybean crops growth cultivated by monoculture and intercropping planting system with maize crops.

| Treatment               | Variable                  | Number of pods per plant (piece) | Number of grains per plant (gram) | Grain weight per plant (grams) | Stover weight per frame area (kg) | Stover weight per Ha (tons/Ha) |
|-------------------------|---------------------------|----------------------------------|----------------------------------|--------------------------------|----------------------------------|--------------------------------|
| Monoculture soybean     |                           | 33.00 b                          | 48.00 b                          | 24.00 b                        | 4.83 b                           | 8.05 b                         |
| Intercropping soybean   |                           | 22.33 a                          | 33.33 a                          | 17.66 a                        | 2.88 a                           | 5.27 a                         |
| Intercropping soybean   |                           |                                   |                                  |                                 |                                  |                                |

Note: the numbers in same column followed by the same letter were not significantly different based on the variance test at the 5% level.

3.3. Competition and profit value of intercropping planting system between maize and soybean crops

Land usage efficiency in intercropping system could be known based on Land Equivalent Ratio (LER) value and Area Time Equivalent Ratio (ATER) and then compared to monoculture system. The LER value describes the competition effect and yield benefit in intercropping, while the ATER value describes the yield advantage in time indicator. The LER value for maize was greater than the LER value for soybeans and showed a value > 1 (Table 7). It indicated that maize and soybean were great suitable for intercropping, it supported by the ATER value produced by each plant which also shows a
value $> 1$ (Table 7). [26] revealed that the LER value $> 1$ described that intercropping was more beneficial than monoculture. ATER value $> 1$ indicates that the intercropping system was able to raise plant efficiency in utilizing available natural resources such as sunshine, moisture and soil nutrients availability [27]. The maize LER was 1.28 values that an additional 28% of land area was needed for a monoculture cropping system to produce the equal production as an intercropping system. The nitrogen element supply was fixed by bean plants in the intercropping system encourages maize plants the root system to expand their reach therefore it had an impact on raising maize yields [11]. The sunshine factor was the main factor determining the LER value of maize and soybean intercropping and the LER value can decreased when the legume plant was shaded [28][29]. This statement was in line with the LER value of soybean plants which was $< 1$ therefore it was poor than the LER value of maize. The intercropping system effect of maize and legumes, mainly peanuts on radiation use efficiency (RUE), photosynthetic active radiation (PAR) and photosynthetic rate had been reported by [30] which illustrates that high LER values follow high RUE and PAR values of plants. RUE and PAR of plants, but this study did not measure the RUE and PAR values.

| Plants | LER | ATER | RCC | A    | CR   | AYL   |
|--------|-----|------|-----|------|------|-------|
| Maize  | 1.28| 3.24 | -2.69| -0.0000441| 4.58 | -0.098|
| Soybean| 0.84| 2.52 | 1.82 | 0.0000441 | 0.21 | -0.158|

Note: LER= Land Equivalent Ratio, ATER= Area Time Equivalent Ratio, RCC= Relative Crowding Coefficient, A= Aggressivity, CR= Competitive Ratio, AYL= Actual Yield Loss

The RCC value indicated that the maize crop did not provide any benefit because it had a negative value (-) and the soybean crop showed an advantage (Table 7). Based on RCC value, it could be interpreted that the intercropping system in this study did not provide benefits. A negative maize RCC value reflects high competition by intercropping, namely soybeans that were linear by a value produced where soybean plants were more aggressive (positive A value) and dominated the population therefore maize plants lose in competition (negative A value) based on the statement by [31]. The soybean crop population in this intercropping study was indeed 3 times larger than the maize plant population. The results of the study in Table 7 show that soybean plants experienced more yield losses than maize (9.8%) in an intercropping system was 15.8%, although soybean plants were more aggressive, competitive and dominated the population. It was suspected that the nitrogen fixation ability by soybean plants was able to compensate for the nitrogen requirement of maize plants [32].

3.4. The carrying capacity of maize crops waste for cattle feed

Maize and soybean waste utilization as alternative feed was an effort to overcome the shortage of ruminant feed in the dry season. Maize waste was included stover, cobs and husk [33] while the stover was a soybean main waste. The carrying capacity of feed from agricultural waste was calculated based on the assumption that 1 Cattle Unit (1 AU) ruminant that an average dry matter requirement was 6.25 kg/day equivalent to 2,282.25 kg/year, crude protein requirement was 240.9 kg/year, and the need for TDN was 4.3 kg/day or the equivalent of 1,569.5 kg/year [34][35]. The intercropping system with an increase in the amount of maize and soybean crop waste. The intercropping agricultural waste production was shown in Table 8.

Maize and soybean waste in monoculture cropping system produce 14.210 kg/Ha and 8.050 kg/Ha, respectively, which was poor than intercropping system that 24.630 kg/Ha. It caused the blank space on maize fields for soybean plants. Maize waste (without stems) made up 78.60% by the intercropping system by soybeans. The greater maize proportion was caused by nitrogen fixation symbiosis in the rhizosphere with soybean as an important encouragement of intercropping maize growth during the growth phase [24]. 1 AU was equivalent on 1 ruminant weighing 455 kg or 7 goats by the assumption that 30% to 40% on intercropping waste was used as feed [36]. The feed carrying...
capacity of maize and soybean intercropping waste was 40% was able to provide 1.353 AU cattle feed. Maize crop waste had low nutrient content compared to young plants. The nutrient content of maize and soybean crops waste parts in postharvest conditions was described in Table 9.

Table 8. Carrying capacity of maize and soybean crops cultivated in monoculture and intercropping.

| Parameters          | Monoculture Maize (T1) | Monoculture Soybean (T2) | Intercropping Maize and Soybean (T3) |
|---------------------|-------------------------|--------------------------|---------------------------------------|
| Waste production (kg/Ha) | 14.210*                | 8.050                    | 24.630**                              |
| Carrying capacity 40% usage (AU) | 780.78                 | 441.75                   | 1353.30                               |
| Carrying capacity 30% usage (AU) | 1041.03                | 588.97                   | 1804.40                               |

Note: *without maize stover; **total waste of maize and soybean in intercropping system; *** The assumption of dry matter requirement in forage for ruminants was 10% of body weight (1 AU = 455 kg).

Table 9. Nutrient composition of maize and soybean plants waste in each part.

|                  | DM  | TDN | CP  | CFi | ADF | NDF | CF  | Ash | Ca  | P  |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Maize Straw*     | 80  | 67  | 9   | 25  | 29  | 48  | 2.4 | 7   | 0.50| 0.25|
| Maize Stover*    | 80  | 59  | 5   | 35  | 44  | 70  | 1.3 | 7   | 0.35| 0.19|
| Maize Cob*       | 90  | 48  | 3   | 36  | 39  | 88  | 0.5 | 2   | 0.12| 0.04|
| Soybean Straw**  | 90  | 52  | 5   | -   | 43  | 54  | 1.2 | -   | 1.21| 0.07|
| Soybean Stover** | 94  | 48  | 5   | -   | 38  | 56  | 1.8 | -   | 0.81| 0.08|
| Soybean Pod Husk** | 91  | 52  | 5   | -   | 42  | 60  | 1.7 | -   | 1.21| 0.06|
| Soybean Hull**   | 92  | 56  | 13  | -   | 49  | 44  | 2.8 | -   | 0.55| 0.18|

Note: *source: [37]; **source: [38]; DM (dry matter); TDN (total digestible nutrients); CP (crude protein); CFi (crude fiber); ADF (acid detergent fibre); NDF (neutral detergent fibre); CF (Crude Fat); Ca (calcium); P (phosphorus).

Maize and soybean intercropping waste generally had poor nutrient content than in the vegetative phase. It is necessary to add or modify feed to increase the nutritional value. [38] revealed that increasing the digestibility value of soybean waste solved by adding molasses or urea. [37] maize stover silage treatment was able to increase total digestible nutrients 13% greater than 59% given directly to livestock. Intercropping system was also assumed to be able to improve the quality of maize and soybean waste, in line with [39] either way to increase maize protein content was through intercropping by beans. [40] revealed that intercropping contributed to greater protein content in forage compared to monocultured maize. [41] added that the crude protein content increased however the NDF level decreased in the mixed silage of maize and legumes such as soybeans and peas compared to the monoculture maize silage. [40] The greater silage digestibility in intercropped maize and beans crops compared to monoculture maize due to increase carbohydrate and crude protein content, it was easily digested. Previous study result that the average daily body gain (ADG) of Simmental cattle with the addition of soybean meal can reach 1035g/day [42]. Feed from maize stover can also be used as an alternative feed such as study by [43] presented that maize cob waste feed that was able to increase the ADG of Ongole Crosbred by 0.74 kg/day. Meanwhile the substitution of 15% or 30% with soybean pods in complete feed was able to increase ADG by 0.73 kg/day and 0.64 kg/day in Madura Cattle [44,45].

4. Conclusions
The monoculture maize crops cultivated by monoculture planting system were better than it intercropped with soybean crops in terms of growth parameters. However, intercropping maize and soybean were produced greater yield components on cobs number, cobs and grains weight than monoculture, except
grains weight per cobs. The monoculture soybean plant in growth, components and yield parameters were greater than intercropping (P>0.05). The ATER, LER, RCC, CR, and AYL values were 3.24; 1.28; -2.69; 4.58; -0.098 on maize and 2.52; 0.84; 1.82; 0.21; -0.158 on soybean. The ATER value of each plant was > 1, which means that there was efficiency in land use and intercropping yield. Those result was followed by carrying capacity in intercropping system by 30% usage can be used for 1.804 AU meanwhile 40% usage was sufficient for 1.353 AU. Intercropping system can be recommended to farmers to increase growth responses of maize-soybean and its potential carrying capacity for cattle feed.

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