Study on production of several soybean varieties with corn intercropping system on dry land in East Lampung, Lampung Province

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Abstract. Soybean is a commodity which is less desirable for farmers to be planted yet it has an increasing high demand for processed food products made from soybean (tofu, tempeh, soy sauce, soy milk, etc.). As a strategic commodity, innovations are needed to provide solutions in order to maintain soybean production, especially in dry land. The purpose of this study was to assess the level of production of several soybean varieties grown using the intercropping system (turiman) with corn on suboptimal dry land. The study was conducted in East Lampung during the 2nd planting season from December 2019 to March 2020. The soybean varieties planted are Dena, Devon, Anjasmoro, and the local one (Tanggamus). The varieties of corn planted are the local existing one. The intercropping system used a corn-soybean pattern of 2 rows of corn and 7 rows of soybeans (Jale 2-7). The corn planted with zigzag pattern. The land area used for intercropping crops is 1 ha. The results showed that the intercropping system between soybeans and corn provided optimal soybean and corn production. The average soybean production was 1.548 kg/ha. The highest soybean production was the Devon variety (2,141 kg/ha) intercropping with corn (BS-18). Meanwhile, the Anjasmoro variety yielded 1.249-1.775 kg/ha, Dena variety yielded 1.428-1.541 kg/ha, and the local Tanggamus variety yielded 0.971-1.790 kg/ha. Corn production was 11.879 – 18.672 kg/ha of wet shelled corn. The average corn production was 15.110 kg/ha. The corn-soybean (Jale 2-7) intercropping system was able to optimize the use of dry land based on rainwater irrigation. This innovation contributed to the improvement of the cropping index from CI = 100 to 150-200.

1. Introduction
Indonesia is currently still struggling to achieve food self-sufficiency. Whereas, rice, soybean and corn are currently mainstay food and animal feed commodities. Corn is used to meet the raw material needs of the animal feed industry. Meanwhile, soybean is used to meet the needs of the household industry for raw materials for producing tofu, tempeh, soy sauce, vegetable milk and so on. Meeting the needs of these foodstuffs is still vulnerable and often depends on imports. Where national corn imports are around 4% of the need while soybean imports are 80% of the need [1,2]. Although the achievement of corn production had increased to 23.16 million ton of corn (up 18.10% from the previous year), while soybean production decreased to 0.89 million tons of soybeans or -8.06% [3].
Corn production in Lampung Province in 2019 reached 2,374,384 ton. The area for corn planting is 426,972 ha, so that corn productivity ranges from 5,561 kg/ha. Soybean production in 2019 reached 12,318 tons planted on an area of 9,334 ha, so that soybean productivity averaged 1,320 kg/ha [4]. At East Lampung district in 2019, corn production reached 904,147 tons planted in a harvest area of 164,940 ha, so that the corn productivity in the area was 5,482 kg/ha slightly below the average corn productivity in Lampung Province. Meanwhile, soybean production reaches 1,490 tons planted in the harvest area of 1,280 ha, so that soybean productivity in East Lampung district is 1,164 kg/ha [5].

On the market, commodity prices for corn and soybeans tend to fluctuate depending on the harvest season. Even though the prices of these two commodities have fluctuated, the demand for corn and soybeans is still relatively high. Especially for soybean commodity, it is recently still a controversial commodity. At the farmer level, farmers are less interested in planting soybeans. Farmers are often reluctant to plant because the selling price tends to be low. However, the need for raw soybeans tends to increase due to the increasing demand for processed food products made from soybeans. The need for corn and soybeans is mainly for industrial needs. This has prompted the government to continue to strive to meet the needs of corn and soybeans in the community.

If the needs of soybeans and corn cannot be met from domestic production, it will be often solved by imports [6]. This condition often triggers the fall in commodity prices for corn and soybeans. For this reason, the government is trying to maintain soybean supplies to meet domestic production. One of the programs is by spurring domestic production of corn and soybeans through intensification and extensification of crops. Corn and soybean crops can be planted on dry land when the rainy season comes.

Potential land resources suitable for agriculture are still very prospective which occupies an area of about 24.5 million ha, one of which is dry land covering an area of 20.15 million ha. The potential for extensification (area expansion) of food production is 13.26 million ha of dry land [7]. However, the problem of agriculture on dry land is that the productivity tends to be low. Dry land tends not to be used optimally. It relies on rainfall as a source of water supply. Whereas water availability is an important element of production which occupies a portion of not less than 16% contributing to increased production [8-11].

In Lampung, dry land can be planted with corn, soybeans, upland rice, cassava or other types of plants that are somewhat tolerant when there is a lack of water. However, innovation is needed to provide solutions to maintain corn and soybean production, especially in dry land. Solving the problems requires technological innovation that can restore land fertility and increase crop productivity in a sustainable manner through intensification and extensification programs. Efforts to restore soil fertility are relatively easy, such as increasing the soil organic matter content to > 2%. The main source of organic matter can be found in large amounts on land or agricultural waste. One source of organic matter is from straw waste if the land is planted with rice, which produces around 10 ton/ha (about 1.5 x grain yield) or the equivalent of 4 - 6 tons of compost/ha/season [12,13,14].

The technology innovation of the intercropping system (turiman) by planting soybeans together with other commodities such as corn on dry land is very prospective to be implemented. Corn and soybeans are prospective plants to be intercropped [15,16]. Several research results on intercropping systems between two plants, as follows, [17] and [18] showed that the productivity of rice and legume intercropping is higher than the monoculture cropping system. Rice and soybean intercropping can be applied because these two plants have complementary effects. Intercropping of cassava with upland rice, corn, soybeans, other beans is very potential and prospective [19]. Research by [20] explained that the intercropping treatment of upland rice plants with sweet corn plants tends to have higher yields than intercropping treatment with other plants.

Thus, the purpose of this study was to determine the level of production of several soybean varieties grown using the intercropping system (Turiman jale 2-7) with corn in suboptimal dry land specific to the Lampung region.
2. Material and Methods
The study was conducted in East Lampung during the second planting season from December 2019 to March 2020. Implementation method was using field demonstration plot, starting with the provision of technical guidance on intercropping technology innovation. The participatory approach involves farmers. This study implemented an innovative intercropping system technology that could increase corn and soybean production in dry land specific to the East Lampung region. The application of innovative corn and soybean intercropping technology was carried out by modifying the planting system to suit the East Lampung region from previous research studies such as the study of [15] dan [16]. The activity was carried out in a dry land covering an area of 1.0 ha in Margototo Village, Metro Kibang District, East Lampung Regency, Lampung Province. The study involved 5 cooperative farmers who have rainfed lowland.

The cropping system model implemented was an intercropping system of corn + soybean with 2 rows of corn and 7 rows of soybean (Turiman Jale 2-7). The tools and supporting materials used in the field are rice seeds, corn seeds, soybean seeds, agricultural production facilities, sign board, wood, bamboo, tape measure, rope, sickle, and so on. The varieties of corn planted are the local existing one (NK-22 hybrid and BS-18 hybrid). The New Superior Varieties (NSV) of soybean were Dena, Devon, Anjasmoro, and the local one (Tanggamus). The corn planted with zigzag pattern.

Corn-soybean row spacing is 30 cm. Corn planting was using (70 + 12.5) = 82.5 cm x 20 cm (intra row of corn), 2 lines of corn plant by Zigzag, 1 seeds per hole, population around 65-70 thousand/ha. Seven line of soybean planting was using 30 cm x 20 cm spacing (in rows), 2-3 seeds per hole with the population of 300 thousand plants/ha. Soybeans were planted 3 weeks earlier than corn. Biodecomposer used was as much as 2 lt/ha (M-Dec, Petrofast, EM-4, etc). Corn seed treatment was using metalaxyl or dimetomorph 200 gr/lt and soybean seed treatment was using Agrisoy 40 gr/8 kg of seeds or Rhizobium 50 gr/5 liter of water. The use of biological fertilizers was 15-30 kg/ha (Kayabio/Agrimeth/Agriceplus/Petroganic, etc.). Organic fertilizer/compost was 2 ton/ha. The use of artificial fertilizers: NPK Phonska for corn 450 kg/ha and for soybean 120 kg/ha, urea for corn was 150 kg/ha and SP-36 for corn is 150 kg/ha, while SP-36 for soybean is 90 kg/ha. And the use of lime/dolomite 2 ton/ha during soil cultivation.

The data observed included plant vegetative variables such as plant height, number of leaves, and generative variables related to production components of corn and soybean. Data analysis was performed with analysis of variance (ANOVA) and continued with Duncan test. The data presented using statistical descriptive.

3. Results and Discussion
3.1. Production of Several Varieties of Soybean in the Corn-Soybean Intercropping System in Dry Land
The intercropping system of corn-soybean 2-7 had been planted through a research demonstration plot in Margototo Village, Kecamaan Metro Kibang, East Lampung Regency. Planting is carried out at the beginning of the rainy season (MH/MT-1) in acid dry land agro-ecosystems, after planting monoculture system corn in the previous planting season. The varieties of corn grown in the intercropping system are NK-22 Jumbo and Bisi-18 that exist in the local area. Meanwhile, the soybeans planted are Anjasmoro, Dena, Devon and local varieties of Tanggamus. The growth of soybean in the corn-soybean Turiman planting showed a good results. Plant growth in the vegetative and generative phases showed superior performance since planting. The results of observations on the vegetative and generative growth of several soybean varieties are shown in Table 1. The initial growth performance of the Anjasmoro, Devon, Dena, and Tanggamus local varieties was quite uniform. Soybean plant height ranges from 75.75 cm to 113.21 cm. The highest plant growth was obtained in the local soybean variety, Tanggamus (113.21 cm), which was intercropped with Bisi-18 corn. The results of analysis of variance and continued with the Duncan test showed significant differences in plant height in the combination of intercropping between several varieties of soybeans and corn. Significant differences in plant height variables were in local soybean varieties Tanggamus
intercropped with BS-18 corn and Devon intercropped with NK-22 corn. Research by [21] stated that plant height growth and number of tillers are influenced by genetic factors and their development during the vegetative and reproductive stages, also influenced by environmental factors.

### Table 1. Soybean plant growth of vegetative and generative with intercopping system at dry land in Metro Kibang, East Lampung, Lampung Province, 2019.

| No | Intercropping System   | Plant height (cm) | Number of branches | Number of filled pods per plant | Number of empty pods per plant | Number of pods | Plant weight (gr) |
|----|------------------------|-------------------|--------------------|---------------------------------|---------------------------------|----------------|------------------|
| A  | Corn (NK-22) + Soybean:|                   |                    |                                 |                                 |                |                  |
| 1  | Anjasmoro              | 79.89<sup>ab</sup>| 3.07<sup>a</sup>   | 81.73<sup>ab</sup>           | 4.20<sup>a</sup>               | 85.93<sup>ab</sup> | 24,2460<sup>ab</sup> |
| 2  | Dena                   | 82.47<sup>ab</sup>| 3.37<sup>ab</sup>   | 84.87<sup>ab</sup>           | 8.80<sup>d</sup>               | 93.67<sup>ab</sup> | 28,3933<sup>b</sup>  |
| 3  | Devon                  | 75.75<sup>a</sup> | 4.07<sup>a</sup>    | 94.67<sup>ab</sup>           | 7.13<sup>bced</sup>            | 101.67<sup>b</sup> | 26,7573<sup>ab</sup> |
| 4  | Lokal                  | 103.23<sup>c</sup>| 3.53<sup>c</sup>    | 100.93<sup>ab</sup>          | 9.60<sup>b</sup>               | 110.53<sup>b</sup> | 20,0847<sup>a</sup> |
| B  | Corn (Bisi-18) + Soybean:|                 |                    |                                 |                                 |                |                  |
| 1  | Anjasmoro              | 87.34<sup>b</sup>| 3.60<sup>ab</sup>   | 105.53<sup>b</sup>           | 7.80<sup>bcd</sup>             | 113.33<sup>b</sup> | 28,7040<sup>b</sup> |
| 2  | Dena                   | 83.23<sup>ab</sup>| 2.93<sup>a</sup>    | 61.93<sup>c</sup>            | 6.27<sup>c</sup>               | 68.20<sup>c</sup> | 25,7720<sup>ab</sup> |
| 3  | Devon                  | 79.63<sup>ab</sup>| 4.02<sup>c</sup>    | 87.07<sup>ab</sup>           | 5.00<sup>c</sup>               | 92.07<sup>ab</sup> | 23,5180<sup>ab</sup> |
| 4  | Lokal                  | 113.21<sup>c</sup>| 3.67<sup>c</sup>    | 97.93<sup>c</sup>            | 4.27<sup>c</sup>               | 102.20<sup>b</sup> | 20,4107<sup>a</sup> |

Source: field observation data, 2019. The area of measurement tile = 2.35 m²

Note: The numbers followed by the same letter in one column show no significant difference in the Duncan test at 5% level.

In the observation variable, the number of branches per soybean plant showed a significant difference between the treatments of the planting system (Table 1). The highest number of branches of soybean was obtained in Devon variety (4.20) intercropping with BS-18 corn. The least number of branches per soybean plant was obtained in soybean varieties Dena (2.93) intercropped with corn varieties BS-18. The results of analysis of variance and continued with Duncan's test showed significant differences in the variable number of branches per soybean plant in a combination of intercropping systems of several varieties of soybeans and corn.

The variable number of filled pods per soybean plant showed a significant difference between the treatments of the planting system (Table 1). The highest number of filled pods per soybean plant was found in Anjasmoro (105.53) intercropped with BS-18 variety. The least number of filled pods per soybean plant was found in soybean varieties Dena (61.93) intercropped with corn varieties BS-18. The results of the Duncan test at 5% level showed a significant difference in the variables of the number of filled pods per soybean plant in a combination of intercropping systems of several varieties of soybeans and corn.

Likewise, the variable number of empty pods per soybean plant showed a significant difference between the treatments of the planting system (Table 1). The highest number of empty pods per soybean plant (9.60) was obtained in Anjasmoro soybean intercropped with BS-18 variety. The least number of empty pods per soybean plant was found in Anjasmoro (4.20) soybean intercropped with NK-22 corn variety. The results of the Duncan test at the 5% level showed a significant difference in the variables of the number of empty pods per soybean plant in the combination of intercropping systems for several varieties of soybeans and corn.

Accordingly, the variable of the total number of pods per soybean plant showed a significant difference between the treatments of the planting system (Table 1). The highest number of pods per soybean plant was found in Anjasmoro (113.33) soybean intercropped with BS-18 variety. The least total number of pods per soybean plant was obtained in soybean varieties Dena (68.20) intercropped with corn variety BS-18. The results of the Duncan test at 5% level showed a significant difference in
the variables of the total number of pods per soybean plant in the combination of intercropping systems of several varieties of soybeans and corn.

The variable of soybean crop stover weight showed a significant difference between the treatments of the cropping system (Table 1). The highest soybean plant stover weight was obtained in Anjasmoro soybean varieties (28.7040 gr) intercropped with BS-18 corn varieties. The lowest soybean plant stover weight was obtained in local varieties (20.0847 gr) intercropped with BS-18 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the variable of soybean crop stover weight in a combination of intercropping systems for several varieties of soybeans and corn.

### Table 2. Soybean production with intercropping system at dry land in Metro Kibang, East Lampung, Lampung Province, 2019.

| No | Intercropping System | Number of seeds per plant | Seeds weight per plant (gr) | Number of plant per tile (2.45 m²) | Weight of soybean per tile 2.45 m² (gr) | Production shelled of soybean (kg/ha) |
|----|----------------------|---------------------------|----------------------------|--------------------------------------|----------------------------------------|-------------------------------------|
| A. | Corn (NK-22) + Soybean: |
| 1. | Anjasmoro | 156,47^{abc} | 23,9067^{abc} | 30,33^{ab} | 218,67^{ab} | 1.249,5^{ab} |
| 2. | Dena | 147,40^{b} | 27,9820^{b} | 29,33^{a} | 250,00^{ab} | 1.428,6^{abc} |
| 3. | Devon | 189,60^{c} | 27,4220^{bc} | 30,67^{ab} | 261,67^{abc} | 1.495,2^{abc} |
| 4. | Lokal | 203,73^{c} | 17,6400^{a} | 32,67^{ab} | 170,00^{a} | 971,43^{a} |
| B. | Corn (BS-18) + Soybean: |
| 1. | Anjasmoro | 201,40^{bc} | 29,8393^{c} | 30,00^{b} | 310,67^{bc} | 1.775,2^{bc} |
| 2. | Dena | 111,87^{a} | 20,3800^{ab} | 39,33^{bc} | 269,67^{abc} | 1.541,0^{abc} |
| 3. | Devon | 165,00^{abc} | 23,1007^{abc} | 44,00^{c} | 374,67^{c} | 2.141,0^{c} |
| 4. | Lokal | 208,87^{c} | 19,0627^{a} | 35,00^{b} | 313,33^{bc} | 1.790,5^{bc} |

Source: field observation data, 2019. Moisture content of harvested soybean 12%. The area of the tile is 2.45 m²

Note: The numbers followed by the same letter in one column show no significant difference in the Duncan test at 5% level.

For production variables, the complete analysis results are shown in Table 2. The variable number of soybean seeds showed a significant difference between the treatments of the planting system. The highest number of seeds per soybean plant was obtained in local varieties (208.87) intercropped with BS-18 corn varieties. The lowest number of seeds per soybean plant was obtained in soybean varieties Dena (111.87) intercropped with BS-18 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the variable number of seeds per soybean plant in the combination of intercropping systems for several varieties of soybeans and corn.

The variable weight of soybean seeds showed a significant difference between the treatments of the planting system. The highest seed weight per soybean plant was obtained in Anjasmoro variety (29.8393 gr) intercropped with BS-18 corn variety. The lowest seed weight per soybean plant was obtained in local varieties (17.6400 gr) intercropped with NK-22 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the variable weight of seeds per soybean plant in the combination of intercropping systems for several varieties of soybeans and corn.
The results of observations on the number of soybean plants per tile showed significant differences between the treatments of the planting system. The area of the soybean plant tile is 2.45 m². The highest number of soybean plants per tile was obtained in the Devon variety (44.00) intercropped with BS-18 variety. The lowest number of soybean plants per tile was obtained in soybean varieties Dena (29.33) intercropped with NK-22 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the variable number of soybean plants per tile in the combination of intercropping systems of several varieties of soybeans and corn.

Observations on the weight of soybean per tile showed significant differences between the treatments of the planting system. The highest weight of soybean per tile was obtained in Devon variety (374.67 gr) intercropped with BS-18 corn variety. The lowest weight of soybean per tile was obtained in local varieties (170 gr) intercropped with NK-22 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the weight variable of soybean per tile in the combination of intercropping systems for several varieties of soybeans and corn.

The observations on soybean production per hectare showed a significant difference between the treatments of the planting system. The highest soybean production per hectare was obtained in Devon soybean (2,141 kg / ha) intercropped with BS-18 corn. The lowest soybean production per hectare was obtained in local varieties (971.43 kg / ha) intercropped with NK-22 corn varieties. The results of the Duncan test at 5% level showed a significant difference in the variables of soybean production per hectare in the combination of intercropping systems for several varieties of soybeans and corn.

3.2. Corn Production in the Corn-Soybean Intercropping System in Dry Land

Table 3 shows the results of observations on the vegetative and generative growth of hybrid corn varieties (NK-22 and BS-18). Corn plant height ranges from 243.4 cm to 255 cm. The highest growth of corn was obtained in BS-18 variety (255 cm) which was intercropped with Devon soybean variety. The results of analysis of variance and continued with Duncan's test showed a significant difference in the height of corn plants in the combination of intercropping between corn and several varieties of soybeans. Significant differences in plant height variables were significantly seen in varieties BS-18 and NK-22 intercropped with soybeans. This is in line with the research results of [21], that the growth of plant height and the number of productive tillers of plants is not only influenced by genetic factors and their development during the vegetative and reproductive stages, but also by growing environmental factors such as spacing.

In the observation variable, the number of leaves per corn plant showed a significant difference between the treatments of the planting system (Table 3). The highest number of leaves of corn was obtained in corn varieties BS-18 (13.8) intercropping with soybean varieties Anjasmoro, Dena, Devon, and local. The least number of leaves per corn plant was found in corn varieties NK-22 (12.4) intercropped with Devon soybean. The results of analysis of variance and continued with Duncan's test showed significant differences in the variables of the number of leaves per corn plant in a combination of intercropping systems for several varieties of corn-soybeans.

In the observation variable, the length of the corn cobs showed significant differences between the treatments of the planting system (Table 3). The highest corn cobs length was obtained in corn variety NK-22 (17.22 cm) intercropped with Devon soybean varieties. The lowest corn cobs were found in the corn variety BS-18 (15.56 cm) intercropped with soybean varieties Dena. The results of analysis of variance and continued Duncan test showed significant differences in the variable length of corn cobs in the combination of intercropping systems for several varieties of corn-soybeans.
Table 3. Corn plant growth of vegetative and generative with intercropping system at dry land in Metro Kibang, East Lampung, Lampung Province, 2019

| No | Intercropping System | plant height (cm) | Number of seed rows lengthwise | Corn cob length (cm) | Corn cob circumference (cm) | Number of seed rows circular | Number of plants per tile (2.35 m²) | Number of cobs per tile (2.35 m²) |
|----|-----------------------|------------------|-------------------------------|----------------------|-----------------------------|-------------------------------|-----------------------------------|-----------------------------------|
| A. Corn (NK-22) + Soybean: |                      |                  |                               |                       |                             |                               |                                   |                                   |
| 1. Anjasmoro                  | 243.8a              | 12.8ab           | 16,840cd                      | 4,980b               | 30,933ab                    | 14,4000a                      | 26ab                              | 24ab                              |
| 2. Dena                       | 245.2b              | 12.6a            | 16,773bc                      | 5,053b               | 30,4000b                    | 14,2667bc                     | 22b                                | 20a                                |
| 3. Devon                      | 243.4a              | 12.4a            | 17,220d                       | 5,040b               | 36,0667b                    | 14,2667bc                     | 26,6667b                          | 25,6667b                          |
| 4. Lokal                      | 245.6b              | 12.8ab           | 17,140d                       | 4,913b               | 31,4000b                    | 14,000b                       | 28,6667b                          | 28b                                |
| B. Corn (BS-18) + Soybean:   |                      |                  |                               |                       |                             |                               |                                   |                                   |
| 1. Anjasmoro                  | 251b                | 13.8b            | 15,720ab                      | 4,633a               | 34,933ab                    | 15,8667b                      | 27,6667b                          | 25ab                              |
| 2. Dena                       | 253.6b              | 13.8b            | 15,650b                       | 4,567a               | 34,0000b                    | 15,7333b                      | 29b                                | 27,6667b                          |
| 3. Devon                      | 255b                | 13.8b            | 15,820c                       | 4,600b               | 35,9333b                    | 15,3333bc                     | 30,6667b                          | 28,6667b                          |
| 4. Lokal                      | 243.4a              | 13.8b            | 15,700ab                      | 4,700a               | 34,5333ab                    | 15,7333c                      | 28b                                | 26,6667b                          |

Source: field observation data, 2019. Moisture content of harvested soybean 12%. The area of the tile is 2.35 m².

In the observation variable, the circumference of corn cobs showed a significant difference between the treatments of the planting system (Table 3). The highest corn cobs circumference was found in corn variety NK-22 (5.0533 cm) intercropped with soybean varieties Dena. The lowest corn cobs circumference was found in the corn variety BS-18 (4.5667 cm) intercropped with soybean varieties Dena. The results of analysis of variance and continued with Duncan's test showed significant differences in the circumference variables of corn cobs in the combination of intercropping systems for several varieties of corn-soybeans.

In the observation variable, the number of rows of lengthwise corn kernels showed a significant difference between the treatments of the planting system (Table 3). The highest number of rows of corn kernels was obtained in corn variety NK-22 (36,0667) intercropped with Devon soybean varieties. The lowest number of rows of lengthwise corn kernels was found in corn variety NK-22 (30,4000) intercropped with soybean varieties Dena. The results of analysis of variance and continued with Duncan's test showed significant differences in the variable number of rows of longitudinal corn kernels in a combination of intercropping systems for several varieties of corn-soybeans.

In the variable component of the observation, the number of rows of circular corn kernels showed a significant difference between the treatments of the planting system (Table 3). The highest number of rows of circular corn kernels was obtained in corn variety BS-18 (15,8667) intercropped with Anjasmoro soybean varieties. The lowest number of rows of circular corn kernels was obtained in corn variety NK-22 (14,000) intercropped with local varieties of soybeans. The results of analysis of variance and continued with Duncan's test showed significant differences in the variable number of rows of circular corn kernels in a combination of intercropping systems for several varieties of corn-soybeans.

The results of observations on the number of corn plants per tile showed significant differences between the treatments of the planting system (Table 3). The area of the corn plant is 2.35 m². The highest number of per-corn corn plants was obtained in corn variety BS-18 (30,667) intercropped with Devon soybean varieties. The lowest number of per-pinned corn plants was obtained in corn variety...
NK-22 (22) intercropping with soybean varieties Dena. The results of the Duncan test at 5% level showed a significant difference in the variable number of corn plants per tile in a combination of intercropping systems of several varieties of corn-soybeans.

The results of the observation on the number of corn cobs per tile showed a significant difference between the treatments of the planting system. The highest number of corn cobs per tile was obtained in corn variety BS-18 (260.47 gr) intercropped with Devon soybean varieties. The lowest number of corn cobs per tile was obtained in corn variety NK-22 (20) intercropped with soybean varieties Dena. The results of the Duncan test at the 5% level showed a significant difference in the variable of the number of corn cobs per tile in the combination of intercropping systems for several varieties of corn-soybeans (Table 3).

The results of observations on the weight of corn cobs per plant showed a significant difference between the treatments of the cropping system (Table 4). The highest weight of corn cobs per plant was obtained in corn variety NK-22 (260.47 gr) intercropped with soybean varieties Dena. The lowest weight of corn cobs per plant was obtained in corn varieties BS-18 (204.73 gr) intercropped with soybean varieties Dena. The results of the Duncan test at 5% level showed significant differences in the weight variables of corn cobs per plant in the combination of intercropping systems for several varieties of corn-soybeans.

The results of observations on the weight of shelled corn per cob showed a significant difference between the treatments of the planting system. The highest weight of shelled corn per cob was obtained in corn variety NK-22 (195.60 gr) intercropped with Devon soybean varieties. The lowest weight of shelled corn per cob was obtained in corn varieties NK-22 (157.33 gr) intercropped with local varieties of soybeans. The results of the Duncan test at 5% level showed a significant difference in the weight variable of shelled corn per cob in the combination of intercropping systems for several varieties of corn-soybeans.

### Table 4. Corn production with intercropping system at dry land in Metro Kibang, East Lampung, Lampung Province, 2019

| No | Intercropping System | Corn cob weight (gr) | Shelled corn weight per cob (gr) | Dry shelled corn weight per cob (gr) | shelled corn weight per 100 (gr) | Corn cob production tile (kg/ha) | Shelled corn weight per tile (gr) | Shelled Corn Production (kg/ha) |
|----|----------------------|---------------------|---------------------------------|-------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| A. | Corn (NK-22) + Soybean: |                     |                                 |                                     |                               |                               |                               |                               |
| 1. | Anjasmoro            | 240,07ab            | 173,40b                         | 141,600                             | 41,5333abc                    | 4.601,7ab                     | 19.582ab                     | 2.831,3ab                     | 12.048ab                      |
| 2. | Dena                 | 260,47ab            | 193,53b                         | 141,800                             | 46,000abcd                    | 4.130,3ab                     | 18.511ab                     | 2.791,5ab                     | 11.879ab                      |
| 3. | Devon                | 259,67ab            | 195,60b                         | 148,200                             | 43,8667abcd                   | 5.301,7ab                     | 22.560ab                     | 3.661,3abcd                   | 15.580abcd                    |
| 4. | Lokal                | 235,87abc           | 157,33a                         | 134,133                             | 37,600ab                      | 5.166,7ab                     | 21.986ab                     | 2.967,5abc                    | 12.628abc                     |
| B. | Corn (BS-18) + Soybean: |                     |                                 |                                     |                               |                               |                               |                               |
| 1. | Anjasmoro            | 210,33a             | 169,67ab                        | 135,533                             | 32,600ab                      | 4.895,0ab                     | 20.830ab                     | 3.872,5abc                    | 16.479abc                     |
| 2. | Dena                 | 204,73a             | 166,60ab                        | 133,000                             | 32,7333a                      | 5.200,0ab                     | 22.128a                      | 4.135,8a                      | 17.599a                       |
| 3. | Devon                | 225,40abc           | 181,000ab                       | 143,800                             | 35,8667ab                     | 5.660,0ab                     | 24.085ab                     | 4.387,9abc                    | 18.672abc                     |
| 4. | Lokal                | 217,40abc           | 171,73ab                        | 139,000                             | 30,5333a                      | 4.976,7abc                    | 21.177ab                     | 3.758,9abc                    | 15.995abc                     |

Source: field observation data, 2019. Moisture content of harvested soybean 12%. The area of the tile is 2.35 m²

Note: The numbers followed by the same letter in one column show no significant difference in the Duncan test at 5% level.

The results of observations on the dry weight of corn shelled per cob showed a significant difference between the treatments of the planting system. The highest dry weight of corn per cob was obtained in corn variety NK-22 (148.2 gr) intercropped with Devon soybean varieties. The lowest dry weight of corn per cob was obtained in corn varieties BS-18 (133 gr) intercropped with soybean varieties Dena. The results of the Duncan test at 5% level showed significant differences in the variables of dry shelled weight of corn per cob in the combination of intercropping systems for several varieties of corn-soybeans (Table 4).

The results of the observations on the weight of 100 corn grains showed significant differences between the treatments of the cropping system (Table 4). The highest weight of 100 corn kernels was
obtained in corn variety NK-22 (46 gr) intercropped with soybean varieties Dena. The lowest weight of 100 corn grains was obtained in corn variety BS-18 (30.5333 gr) intercropped with local varieties of soybeans. The results of the Duncan test at 5% level showed significant differences in the weight variables of 100 corn kernels in the combination of intercropping systems for several varieties of corn-soybeans.

The results of observations on the weight of corn cobs per tile showed significant differences between the treatments of the cropping system (Table 4). Corn plant tiles covering an area of 2.35 m². The highest weight of white cobs was obtained in corn variety BS-18 (5,660 gr) intercropped with Devon soybean varieties. The lowest weight of white cobs was obtained in corn variety NK-22 (4,130 gr) intercropped with soybean varieties Dena. The results of the Duncan test at the 5% level showed a significant difference in the weight variables of corn cobs in the combination of intercropping systems for several varieties of corn-soybeans.

The results of observations on the production of corn grain or cobs per hectare showed significant differences between the treatments of the cropping system. The highest production of shelled corn per hectare was obtained in corn variety BS-18 (24,085 kg/ha) intercropped with Devon soybean varieties. The lowest production of corn per hectare was obtained in corn variety NK-22 (18,511 kg/ha) intercropped with Dena soybean varieties. The results of the Duncan test at 5% level showed significant differences in the variables of production of corn beans per hectare in the combination of intercropping systems for several varieties of corn-soybeans (Table 4).

The results of shelled corn production per tile tend to be distributed in the same direction as the production of corn cob per hectare. The highest yields of shelled corn per tile were obtained in variety BS-18 (4,387.9 gr) intercropped with Devon soybean varieties. The lowest yield of shelled corn per tile was obtained in corn variety NK-22 (2,791.5 gr) intercropped with soybean varieties Dena. The results of the Duncan test at 5% level showed a significant difference in the variables of shelled corn per tile in the combination of intercropping systems of several varieties of corn-soybeans. The area of corn tile is 2.35 m². Likewise, the highest yield of shelled corn per hectare was obtained in the BS-18 variety (18,672 kg / ha) intercropped with Devon soybean varieties. The lowest yield of harvested shelled corn per hectare was obtained in corn variety NK-22 (11,879 kg / ha) intercropped with soybean varieties Dena. The results of the Duncan test at 5% level showed a significant difference in the variables of shelled corn production per hectare in the combination of intercropping systems for several varieties of corn-soybeans (Table 4).

The difference in yield is thought to be influenced by environmental factors in which the plant grows. Environmental conditions greatly affect the ability of physiological functions and genetic potential of plants in the productive phase [22]. Furthermore, according to [23], the production of a plant is the final result of the interaction between the genetic factors variety, environmental conditions and management through physiological processes. In addition, several studies showed that ecological engineering have increased production, such as the provision of organic matter [24,25,26], cropping patterns [27], and rice - secondary crops integration system [24,25]. However, ecological engineering by planting flowering and secondary crops has not shown a significant difference in suppressing pests [28].

3.3. Efforts to Increase the Crop Index

Cultivation on dry land usually rely on rainfall as water resources. For this reason, the right strategy that can be applied is by calculating planting time according to the seasonal calendar and the distribution of rainfall that will provide a sustainable annual cropping pattern. In the dry land of East Lampung, farmers usually plant corn only once during the rainy season in a monoculture manner. The implementation of the innovative intercropping technology between corn and soybeans is a clear evidence of the increase of cropping index (CI). The cropping index from CI = 100 can be increased to CI = 150-200. The main key is to anticipate appropriately in starting to plant corn and soybeans. So
that at the end of the first rainy season, the plant can immediately be harvested and usually there is still enough rain for planting other crops commodities.

4. Conclusion
The intercropping system between soybeans and corn provided optimal soybean and corn production. The average soybean production was 1,548 kg/ha. The highest soybean production was the Devon variety (2,141 kg/ha) intercropped with corn (BS-18). Meanwhile, the Anjasmoro variety yielded 1,249-1,775 kg/ha, Dena variety yielded 1,428-1,541 kg/ha, and the local Tanggamus variety yielded 971-1,790 kg/ha. Corn production was 11,879 - 18,672 kg/ha of wet shelled corn. The average corn production was 15,110 kg/ha. The corn-soybean (Jale 2-7) intercropping system was able to optimize the use of dry land based on rainwater irrigation. This innovation contributed to the improvement of the cropping index from CI = 100 to 150-200 by anticipating and accelerating planting in the first planting season (rainy season) so that water will still be obtained in the following planting season.

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