Implementation of cropping patterns for improving paddy planting index

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Abstract. The development of cropping patterns is very important to support the increase in the rice cropping index to increase production. Efforts to increase the rice cropping index are based on the availability of superfast varieties which can increase the rice cropping index in rainfed lowland and dry land. The study design was a randomized block design. This study was conducted with 2 cropping patterns, namely 1) paddy-paddy-paddy using Inpari 24, Inpari 31, and Inpari 34 varieties; and 2) paddy-peanut-paddy using Inpari 31 and Inpari 34 varieties, while the peanut variety used are Talam 2. The method of analysis of the results of the assessment is carried out with descriptive and explanatory methods for the socio-economic aspects. While the technical aspects, the data collected will be analyzed using ANOVA analysis, and further testing is carried out using the LSD test at the 5% level. The results of the study show that the development of paddy-paddy-paddy and paddy-peanut-paddy cropping patterns can be carried out well if there is sufficient water availability. The use of paddy-paddy-paddy cropping patterns must be supported by the availability of early-age paddy seeds and sufficient water availability. The cropping pattern for paddy-peanut-paddy using peanut Talam 2 variety. From an economic aspect is more feasible than the paddy-paddy-paddy, but cropping pattern with a size of R/C 2.03. In terms of advantages, the paddy-paddy-paddy cropping pattern has a greater advantage than the paddy-peanut-paddy cropping pattern.

Keywords: planting pattern, paddy, peanut, paddy fields

1. Introduction
The rate of population growth and the level of consumption per capita which is getting higher requires food needs, especially rice. Provision of food, especially rice in sufficient quantities at a price that is affordable to the wider community, remains the main priority for national development. Apart from being the staple food of more than 95% of the Indonesian people, rice cultivation has also provided employment for around 20 million rural farmer households, so that from a national food security perspective its function is very important and strategic [1].

Efforts that can be made to increase rice production are increasing the cropping index and productivity. Increasing the cropping index can be done considering the availability of water available throughout the season. In addition, efforts to increase the rice cropping index are based on the availability of superfast varieties that can increase the rice cropping index in rainfed and dry land, so it is hoped that an increase in rice production and productivity will occur. The Indonesian Agency of Agricultural Research and Development, through the Indonesian Center for Rice Research, has produced early maturing rice varieties with an age of 85 days, even though the productivity is still below five tons. This means that
through one more stage, breeders will be able to produce short-lived rice with high productivity. It is hoped that the increase in the cropping index can overcome the sloping increase in rice production because through the increase in the rice cropping index, the area of rice plants and the harvested area will be doubled from the area planted now, so that rice production increases, sustainable rural employment will reduce urbanization to the city [1].

Based on the descriptions above, it is important to carry out activities to increase the rice planting index in rainfed lowland and dry land in Bangka Belitung Islands. The study of the development of cropping patterns to support the increase in the rice cropping index is a continuation of the Agricultural Innovation Support for Increasing the Rice Plant Index in Rainfed and Dry Lands in the Bangka Belitung Islands which began in 2017. The implementation of activities in 2018 was the identification of water resources and the use of the planting calendar in the implementation of the development of cropping patterns supports the Increase of the Rice Planting Index in the Bangka Belitung Islands. An integrated planting calendar is a guideline or a tool that provides information on climate predictions, planting times, disasters, recommendations for agricultural production facilities, as well as a monitoring system for rice, maize, soybean in rice fields and swamps [2].

2. Materials and methods

2.1. Time and location
The Study on the Development of Planting Patterns to Support the Increase of the Rice Planting Index will be carried out from January to December 2018 in the rice fields of Lake Nujau, Gantung Village, Gantung District, East Belitung Regency, Bangka Belitung Islands Province.

2.2. Tools and materials
The tools used were hoes, sickles, machetes, gauges, saws, and other agricultural tools. The materials used in the research were rice seeds, organic fertilizers, inorganic fertilizers, lime, medicines, and others

2.3. Procedure
This study was carried out with 2 cropping patterns, namely 1) paddy-paddy-rice using early age varieties Inpari 19 and Inpari 34; and 2) peanut-rice varieties use Inpari 31 and Inpari 34 varieties, while peanut varieties use Talam 2.

The type of data to be collected is plant adaptability data, including the growth performance and productivity of rice plants, as well as the potential area of land and types of irrigation infrastructure services.

The method of analysis was carried out with descriptive and explanatory methods for the socio-economic aspects. While the technical aspects, the data collected will be analyzed using ANOVA analysis, and further testing is carried out using the LSD test at the 5% level, while the economic aspects use financial analysis.

3. Results and discussion

3.1. Result
The data from the observation of the production aspect showed that the difference between the two cropping patterns was only in the second planting season (MT), namely the types of commodities planted. In the second growing season the commodities are planted with rice and peanuts. From the aspect of peanut production, it is lower than rice, but from the aspect of land productivity it increases. This means that previously water-deficient land could not be used for rice planting can be planted with peanuts. In the second planting season, rice productivity was higher by 6.2 t/ha than the first planting season of 5.4 t/ha and the third planting season of 4.4 t/ha. Data on the tabulation of production aspects can be seen in table 1.

The results of the financial analysis show that the paddy-peanut-paddy cropping pattern has a greater profit than the rice-peanut-rice cropping pattern of Rp. 27,850,000 while the rice-peanut-rice planting
The results of the water resources identification survey conducted in 6 districts that have paddy fields, namely West Bangka, Bangka, Central Bangka, South Bangka, Belitung, and East Belitung shows that the potential for an increase in planted area is quite large, reaching 15,540 ha. Most types of infrastructure services are embung and damparit with a service area of 6,992 ha and 5,393 ha, respectively. The area of land surveyed is a potential area for increasing the cropping index. The potential for land expansion and types of irrigation infrastructure services can be seen in table 3.

### 3.2. Discussion

The existing rice fields in the province of Bangka Belitung Islands are rainfed and new paddy fields are printed. Therefore, the land is greatly influenced by rainfall. The absence of permanent or semi-permanent irrigation will have an impact on cropping patterns in the area. The cropping pattern currently being implemented is still fallow rice, which has sufficient water availability paddy-fallow and paddy-fallow which has insufficient water availability. In this study, the paddy-fallow-paddy and paddy-peanut-fallow cropping patterns were tried. The results of the study show that the use of the paddy-fallow-paddy cropping pattern can be done in one year if there is sufficient water availability and there is no climate change. In the case of the 2018 planting season, there was a change in climate so that the third planting season was delayed to November, which is usually planting in September. Thus, the harvest is carried out in the following year so that the paddy-fallow-paddy cropping pattern is not carried out in the same year.

### Table 1. Implementation of 2018 cropping patterns

| No | Cropping Patterns | MT I | MT II | MT III |
|----|-------------------|------|-------|--------|
| 1  | Paddy-Paddy-Paddy | 5.4  | 6.2   | 4.4    |
| 2  | Paddy-Peanut-Paddy| 5.4  | 2.0   | 4.4    |

### Table 2. Analysis of the application farm cropping patterns to increase cropping index

| No | Description | Paddy-Paddy-Paddy | Paddy-Peanut-Paddy |
|----|-------------|--------------------|--------------------|
|    |             | Physical | Unit (000) | Value (000) | Physical | Unit (000) | Value (000) |
| 1  | Cost        |          |           |            |          |           |            |
|    | a. Saprodi  | 3 pkt   | 2,300     | 6,900      | 3 pkt   | 2,300     | 6,900      |
|    | b. Labor    | 250 oh  | 85        | 21,250     | 234 oh  | 85        | 19,890     |
|    | Total       |          |           | 28,150     |          |           | 26,790     |
| 2  | Benefit     | 16       | 3,5       | 56,000     | 9,8      | 3,5       | 34,300     |
|    | Profit      |          |           | 27,850     |          |           | 27,510     |
|    | BC ratio    |          |           | 1.99       |          |           | 2.03       |
[13] has conducted an assessment of the initial planting time of food crops in eastern Indonesia. Most of the farmers in eastern Indonesia plant food crops both lowland rice, upland rice, and maize on Oct II/lll for MT I and Feb II/lll for MT II every year, although the peak of planting varies greatly between provinces. This happens because it is greatly influenced by rainfall in the rainy season which is influenced by equatorial rainfall patterns. Realization of planting time for farmers is largely determined by the start of the rainy season that occurs in eastern Indonesia so that only a few places can plant rice in MK I, and generally it is replaced with secondary crops. Inthavong et.al. (2011) stated that determining the initial planting time for rainfed rice can be based on the ground water balance. According to Runtunuwu et.al., (2012a); Runtunuwu et.al., (2012b) spatial mapping of planting times will also assist in planning where and when these crops are cultivated. The results of the research by Nakano et.al., (2008) reported that the initial setting of planting time which was faster than normal planting time resulted in 14.9 percent higher rice dry weight. Based on Lux's research (2010), planting time arrangements can increase plant productivity. Shrestha et.al. (2011) concluded that determining the right initial planting time can overcome the loss of plant nutrients, especially during the transition from the dry season to the rainy season.

Table 3. The results of the 2018 SDA survey in the Bangka Belitung Islands Province

| No | Description     | Embung | Damparit | Pumping | Long Storage | Shallow Well | Total |
|----|-----------------|--------|----------|---------|--------------|-------------|-------|
| 1  | West Bangka     | 565    | 569      | 350     | 98           | 0           | 1582  |
| 2  | Bangka          | 550    | 425      | 490     | 0            | 0           | 1465  |
| 3  | Middle Bangka   | 100    | 80       | 20      | 0            | 0           | 200   |
| 4  | South Bangka    | 4575   | 3084     | 300     | 1280         | 10          | 9249  |
| 5  | Belitung        | 480    | 265      | 150     | 0            | 0           | 895   |
| 6  | East Belitung   | 722    | 970      | 310     | 147          | 0           | 2149  |
|    | Total           | 6992   | 5393     | 1620    | 1525         | 10          | 15540 |

The availability of rice varieties and labor also determines the initial planting time for farmers. The diversity of environmental factors that affect the planting time of food crops in a region will be integrated into the realization of planting time by local farmers so that it differs from place to place (Ferng, 2009; Mulyaningsih et al., 2010). To support the increase in the cropping index, there needs to be improvements and making irrigation so that water availability throughout the year. If the availability of sufficient land in the Province of Bangka Belitung Islands, either existing or printing new rice fields, can be increased the index for planting from once to twice or from two to three crops. According to Syahbuddin, et.al (2018) increasing IP is carried out through the use of water resources around dry and rainfed land locations. These water resources can be used for the construction of water infrastructure that meets water needs. The type of irrigation infrastructure can be adjusted to the availability of local water sources. Kartiwa (2017) states that efforts to increase the IP of rainfed lowland and dry land through the construction of water harvesting infrastructure are carried out in stages starting from a survey to identify water resources and target irrigation services, design water management and determine the right type of water infrastructure according to the resource, available water and targeted irrigation services. Types of water harvesting infrastructure consist of trench dams, reservoirs, long storage and shallow groundwater wells.
4. Conclusion
1. The development of rice cropping patterns using paddy-paddy-paddy and paddy-peanut-paddy can be done well if there is sufficient water availability.
2. Adequate infrastructure and the existence of a good source of irrigation water can increase the cropping index in the Bangka Belitung Islands Province.

References
[1] Haryono. 2012. Climate change and food crop production technology innovations. Agricultural Research and Development Agency. Jakarta
[2] Agricultural Research and Development Agency. 2018. Integrated planting calendar (KATAM Terpadu). Agricultural Research and Development Agency. Jakarta
[3] Suratiyah, K. 2006. Agricultural science. Self-Help Spreader. Jakarta.
[4] Runtunuwu E, H. Syahbuddin, F. Ramadhani, Y. Apriyana, K. Sari, and W.T. Nugroho. 2013. Overview of time to plant food crops in eastern Indonesia. Journal of Food, Vol. 22 No. March 1: p. 1-10
[5] Inthavong T, M. Tsubo, dan S. Fukai. 2011. A Water balance model for characterization of length of growing period and water stress development for rainfed lowland rice. Field Crops Research 121 291-301.
[6] Runtunuwu E., H. Syahbuddin, and F. Ramadhani. 2012a. The dynamics of planting rice plants in Kalimantan. Journal of Agronomy 40 1 8-14.
[7] Runtunuwu E., H. Syahbuddin, F. Ramadhani, and W.T Nugroho. 2012b. Dynamics of paddy planting calendar in Sulawesi. Food Magazine 21 113-124.
[8] Nakano H., S. Morita, I. Hattori, dan K. Sato. 2008. Effects of planting time and cultivar on dry matter yield and estimated total digestible content of forage rice in Southwestern Japan. Field Crops Research 105 116-123.
[9] Laux P., G. Jackel, R. M. Tingem, and H. Kunstmann. 2010. Impact of climate change on agricultural productivity under rainfed conditions in Cameroon—a method to improve attainable crop yields by planting date adaptations. Agricultural and Forest Meteorology 150 1258- 1271.
[10] Shrestha S, F, Asch, M. D, dan M. Becker. 2011. Cropping calendar options for rice-wheat production systems at high-altitudes. Field Crops Research 121 158-167.
[11] Ferng J.J. 2009. Effects of food consumption patterns on paddy field use in Taiwan. Land Use Policy 26 772-781.
[12] Mulyaningisn E.S., H.Aswidinnoor, D. Sopandie, B.F. Pieter. 2010. Transformation of Indica rice in Batutegi and Kasalath cultivars with HD-Zip Regulator gene for assembling drought tolerant varieties. J. Agron Indonesia 38 1-7.
[13] Syahbuddin, A., R. Purnamayani, U. Humaedah, Y. Apriyatna, W. Estiningtiyas, B. Kartiwa, and Muharam. 2018. Guidelines for implementing technological innovations for increasing the planting index. Center for Agricultural Technology Assessment and Development. Bogor
[14] Kartiwa, Budi. P. Rejekkiningrum, H. Sosiawan, N. Sutrisno, N. Heryani, S. Hadi Talaoohu, K. Sudarman, A. Hamdani, Haryono, G. Jayanto, Harmanto and D. Nursyamsi. 2017. Technical guidelines for the implementation of water harvest infrastructure. Agricultural Research and Development Agency. Jakarta