Development of Boyolali local peanut and composite corn planting patterns on rainfed rice fields

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Abstract. The location of the experiment was in the agro-ecosystem rainfed ricefield, Nogosari, Boyolali from June 2017 to September 2017. The research consisted of a survey of technology components commonly applied at the farmer level as well as demonstration plots of technology components in accordance with the integrated crop management of palawija (composite corn and local peanuts). Farmers' understanding of the cultivation technology of peanuts and corn were very high. The yield of ubinan of Boyolali local peanut monoculture was still higher in farmer dosage (7.5 tons / ha) compared to the recommendation from Center for Agricultural Technology Studies (CATS) of Central Java. The yield of local peanut intercropping composite corn was higher (6.1 ton / ha) compared to the recommendation of CATS (5.0 ton / ha). The yield of monoculture corn cropping is 3.6 tones / ha at recommended dosage treatment and Provit A variety is 4 tons / ha. Meanwhile, the yield of corn in intercropping was experiencing crop failure. Thus, the intercropping pattern of peanuts and composite corn can be accepted by farmers and can develop in this area if assisted by dissemination in the form of demonstration plots in rainfed agro-ecosystems ricefield.

1. Introduction
The food barn is a concept of sustainable development of food sustainability. This concept concerns the preservation of environmental resources in a modern and integrated agricultural business system. Some of the components of modern technology used as references in the food barn concept include: 1. the use of composted harvest waste on the ground, 2. the existence of commodity like nuts or plants that require soil processing on the ground; 3. sanitation of host pests and diseases; 4. the use of improved site-specific adaptive varieties between rice fields; 5. applying a cropping pattern with a variety of commodities in one area of land with a specific method of agro-ecosystem location; 6. balanced fertilization for each specific location commodity, thus there is optimal nutrient supply; 7. integrated management and control of pests and diseases; 8. anticipating waste pollution which comes from outside the ecology of the land; 9. optimal land preparation for plant growth; 10. planting in the right planting season simultaneously on one stretch; 11. maintenance of irrigation sources and infrastructures, thus water is available for plants; 12. harvesting and storing rainwater for irrigation during the dry season. This area of food storage integrated with agriculture (plants), livestock, and fisheries. Between sectors are mutually complementary for each other [1].

For this reason, cross-sectoral synergy is an absolute prerequisite for achieving the target of optimally utilized food storage. Some of this land is suboptimal, such as dry land, tidal swamp, and deep swamp where its productivity is relatively low due to various constraints, such as shortage and / or excess of water, high soil acidity and salinity, poisoning and nutrient deficiency. If suboptimal land is engineered
with the application of cultivation technology innovation and adequate infrastructure support, then the land can be converted into productive land for the development of cultivation of various agricultural commodities. In 2016, Indonesia was recorded as one of the countries achieved the largest increase in food security among the observed countries. The increase in food security was seen from three aspects, namely affordability, availability, quality and safety [1].

Food sovereignty must also make farmers the subject, not the object of development. The development of cropping patterns is influenced by the agroecosystem. Permanent cropping patterns are found in irrigated rice fields (paddy-paddy-paddy) and dry land in foreland (vegetable-vegetable-vegetable). Meanwhile, for rainfed rice field and dry land in lowland, farmers will have different cropping patterns from one another. In farming and crop cultivation, farmers are used to planning a year's cropping pattern. The selection of commodities and plant varieties is adjusted to the condition of consumers, technological capabilities, soil fertility, water availability and the potential for pest attacks that commonly occur in location of land. On rainfed rice field in lowland, farmers only rely on rain as a source of irrigation. Therefore, failure of planting and harvesting is very common for rainfed farmers [2]. The location for the development of food crop cropping patterns is aimed at locations which are not yet in accordance with the resource conditions and the suboptimal productivity of the selected commodities. Land and water are key factors in the development of a country's agricultural sustainability[3].

The less irrigation network in an area, the higher the area of the paddy field. The regency with the largest area of harvested rice field in Central Java in 2015 was Wonogiri Regency, followed by Blora, Cilacap, Kebumen and Rembang [4].

2. Materials and methods

The study of the components of the intercropping technology for peanut and composite corn was carried out in the agro-ecosystem rainfed rice field of Nogosari District, Boyolali Regency during the third planting season (June to October) 2017. This activity includes several activities: a) sub-district level meeting activities to determine the dominant cropping patterns and technology components in rainfed rice field, b) demonstration plots for the introduction of composite corn commodities and the addition of biodecomposers to secondary crops and c) evaluation of activities as a basis for feedback on activities.

| No. | Planting system                  | Village        | PUTK recommendation / ha (kg) | Farmer Fertilizer / ha (kg) |
|-----|---------------------------------|----------------|-------------------------------|----------------------------|
|     |                                 |                | Phonska Urea ZA SP 36         | Phonska Urea ZA SP 36       |
| 1.  | Monoculture of peanut           | Tegalgiri      | 200                           | 120 167 84                 |
| 2.  | Monoculture of corn             | Jeron          | 350 100 100                   | 750 250                    |
| 3.  | Corn in the intercropping system Peanuts in the intercropping system | Jeron | 350 150 100 | 750 250 |
|     |                                 |                | 250                           | 25 167 84                  |
| 4.  | Corn in the intercropping system Peanut in the intercropping system | Moist | 350 200 115 | 750 250 |
|     |                                 |                | 200                           | 225 60 60 160              |
| 5.  | Monoculture of peanut           | Moist          | 200                           | 25 60 60 160               |
The locations of activities are: 1) Rembun Village by local varieties of peanut monoculture system, 2) Tegalgiri Village by local varieties of peanut monoculture system, 3) Jeron Village by system of corn monoculture varieties of Srikandi Kuning and Provit A, 4) Rembun Village with intercropping local varieties of peanuts with corn varieties of Srikandi Kuning and intercropping of local varieties of peanuts with corn varieties of Provit A, 5) Jeron Village by intercropping local varieties of peanuts with corn varieties of Srikandi Kuning and intercropping of local varieties of peanuts with corn varieties of Provit A. Each plot had different fertilizer doses for peanuts and corn. After being analyzed, each location had different treatments (shown in Table 1).

Farmers’ feedback and response activities are carried out at small meetings at the sub-district level. Respondents drawn were about 40 farmers and 10 field officers. The data were analyzed descriptively.

3. Results and discussion

3.1. The area for the development of intercropping patterns

Rice cultivation in rainfed rice field is highly dependent on climate and rainfall. The harvest area for rainfed rice field is in the January-April period which is the result of planting in the September-December period of the previous year. Based on data on rainfed rice field production from 2006, production of paddy experienced a significant increase with a peak in 2014. In 2015 there was a decrease due to lower rainfall compared to 2014. The harvested area from January to April in Central Java was around 57,373 ha, from May to August was 13,145 ha and from September to December was 719 ha. The harvest area for rainfed rice field in Boyolali Regency for planting from January to April was 2,805 ha, while in May August it was around 221 ha [4].

The corn commodity is an alternative commodity for some farmers, but it has not become the farmers’ choice to become the main commodity in a large area during the dry season. Likewise, cropping systems of monoculture of peanuts are still an option that is cultivated in every agro-ecosystem. Only on dry land, there are farmers who use multiple cropping or relay cropping between annual crops and food crops. On rainfed rice field, farmers will choose the cropping pattern of rice-palawija-palawija or rice-palawija-horticultural crops. The cropping pattern is a form of land use by considering natural and human resources in plant cultivation in order to obtain the best possible results sustainably. Cropping patterns develop according to: a) soil and climate, b) science and technology, c) economy and d) socio-culture [5]. Therefore, the arrangement of cropping patterns in rainfed rice field depends on the ability of farmers to plan.

There are three types of cropping patterns, namely: monoculture, polyculture (intercropping) and crop rotation. The three cropping patterns have their own advantages and disadvantages. The cropping pattern has an important meaning in the crop production system. This cropping pattern means utilizing and integrating the various available components (agro-climate, soil, plants, pests and diseases, engineering and socio-economy). The cropping pattern in tropical areas such as in Indonesia is usually arranged for 1 year by considering rainfall (especially in areas / land that are completely dependent on rain). Thus, the selection of types / varieties to be planted needs to be adjusted to the conditions of available water or rainfall. Intercropping is an effort to plant several types of plants on the land at the same time, which are arranged in such a way as plant rows. Planting in this way can be done on two or more types of plants that are relatively of the same age, for example corn and peanuts, or it can also be on several types of plants of different ages. In the intercropping cropping pattern, it is best to choose and combine plants that have relatively deep roots and plants that have relatively shallow roots [6].

Several technologies which can be applied in rainfed rice field areas include water-saving technology, use of superior variety seeds, cultivation techniques adapted to seeds / commodities, improved cultivation (soil cultivation, fertilization, pest and disease control and improved methods of harvest and post-harvest) and the early planting period (November / December) aims to get better results. There are 5 cropping patterns in Boyolali Regency, including paddy-paddy-paddy cropping patterns (in irrigated and rainfed rice field areas (in La Nina climate)), paddy-paddy-peanut cropping patterns (in rainfed rice field), paddy-peanut / corn cropping patterns (in rainfed rice field), peanut-paddy cropping
patterns on dry land and peanut + kaempferia galanga cropping patterns or kaempferia galanga monoculture on dry land.

The introduction of cropping patterns and intercropping systems between peanuts and composite corn in this region is easy because input is available for these two commodities. However, farmers need technical guidance on the land for composite corn cultivation. In this activity, the choice of composite corn was because the farmers had developed local corn, namely Unyil. To disseminate new commodities, it is necessary to have a demonstration plot for the introduced varieties, namely Srikandi Kuning and Provit A.

3.2. Monoculture of peanut

The location of the demonstration plots was carried out in 3 villages, namely: Rembun, Jeron and Tegalgiri. Each location has an area of 2,000 m². Boyolali locally grown varieties. The treatments that are introduced as lessons learned for farmers are: 1) the fertilizer dose for the farmer's planting system + the tile spacing (15 cm × 15 cm) and 2) the fertilizer dose according to the paddy soil test kit + Agrodeco application + legowo row spacing (40 cm × 20 cm × 20 cm).

![Figure 1. The agrodeco application before planting and planting is in accordance with the recommendations of the Central Java CATS](image)

Yield from the monoculture of peanut demonstration plot (9 m²) are as follows:

| No. | Treatment                      | Ubinan Result (Kg) / ubinan | Kg / ha fresh weight | Total Crop | Fresh Weight of Bean Pod (gr) | Fresh Weight of Seed (gr) | Total of seeds |
|-----|--------------------------------|-----------------------------|----------------------|------------|-------------------------------|--------------------------|-----------------|
| 1.  | Rembun Farmers                 | 6.8<sup>a</sup>             | 7.529                | 227<sup>a</sup> | 29<sup>a</sup>               | 19.7<sup>a</sup>         | 36<sup>a</sup>   |
| 2.  | Recommendations of Rembun      | 5.1<sup>b</sup>             | 5.637                | 179<sup>b</sup> | 29<sup>a</sup>               | 18.7<sup>a</sup>         | 33<sup>a</sup>   |
| 3.  | Tegalgiri Farmers              | 4.0<sup>b</sup>             | 4.429                | 233<sup>a</sup> | 17<sup>b</sup>               | 10.3<sup>c</sup>         | 20<sup>b</sup>   |
| 4.  | Recommendations of Tegalgiri   | 3.9<sup>b</sup>             | 4.351                | 175<sup>b</sup> | 22<sup>ab</sup>              | 15.0<sup>b</sup>         | 25<sup>b</sup>   |

The highest yield of peanut ubinan in the treatment of monoculture from Rembun Village farmers was significantly different from the recommended treatment and other treatments. The yield of ubinan treatment by monoculture farmers in Rembun Village was an average of 6.8 kg with 227 plants more than the treatment recommended by monoculture in Rembun Village. Fresh weight of bean pod, fresh weight of seed and number of seeds for each plant were not significantly different from the treatment of the monoculture recommendation in Rembun Village. In the Tegalgiri village, the results of the ubinan treatment of farmers were not significantly different from the recommended treatment, with the number of plants in the treatment of the farmers was much higher. Fresh weight of Bean Pod, fresh weight of seed and number of seeds for each plant were not significantly different from the treatment of the monoculture recommendation in Tegalgiri Village. The yield of peanut ubinan, fresh weight of bean pod, fresh weight of seed and number of seeds in the treatment of monoculture by Rembun Village farmers were significantly higher than that of Tegalgiri Village monoculture farmers, but the number of plants was not significantly different. With these conditions, it can be stated that the habits of farmers with narrow spacing and excessive doses of fertilizer, yields still not significantly different.
3.3. Monoculture of corn in rainfed rice field

The corn commodity is an alternative commodity grown in rainfed rice fields in Jeron Village, Nogosari District. Likewise, the cropping system applied is monoculture. However, the cultivated variety is unyil corn, which is a corn variety for fodder, especially for poultry. If farmers choose other varieties, the choice will be sweet corn, which is harvested young. For yellow corn varieties, not many farmers have planted it.

The introduction of the technology applied was: a) Srikandi Kuning and Provit A varieties with farmer dosages and b) Srikandi Kuning and Provit A varieties with doses based on PUTK and agrodeco applications. Agrodeco application is carried out one week before planting.

![Figure 2. Agrodeco applications, planting, cropping and harvesting corn in Jeron Village, Nogosari District](image)

| No. | Treatment         | Cob Length | Number of lines | Total Latitude | The dry weight of cob beans | Tile Results |
|-----|-------------------|------------|-----------------|----------------|----------------------------|--------------|
| 1   | Farmer's Srikandi | 15.00a     | 14.00a          | 24.00b         | 111.67b                    | 3.3333a      |
| 2   | Recommended Srikandi | 17.00a    | 12.67a          | 27.00b         | 132.00a                    | 3.6667a      |
| 3   | Farmer's Provit A  | 16.67a     | 15.33a          | 26.00b         | 130.00a                    | 3.6667a      |
| 4   | Recommended Provit A | 16.00a    | 13.33a          | 29.33a         | 132.67a                    | 4.0000a      |

The yields of Srikandi kuning and Provit A, either by farmer or recommended treatment, were not significantly different. However, the Provit A variety was relatively higher than Srikandi Kuning. The length of cobs and the number of rows of Srikandi kuning and Provit A corn were not significantly different, both in the farmers and recommended treatment. The amount of latitude in the treatment of farmers was not significantly different from the recommended monoculture for both Srikandi kuning and Provit A varieties. The dry weight of cob beans of Srikandi Kuning on the recommended treatment was higher, significantly different from the farmer's treatment. The dry weight of cob bean of Provit A variety in the recommended treatment was relatively higher, not significantly different from the treatment of farmers.

The average height of peanut plants planted in the Experimental Garden of the Faculty of Agriculture, Muara Bungo Binjai University, Bungo Regency on June 4 to September 30 was influenced by local microorganisms. The results showed that the MOL dose of 0 (37 cm), 10 (42 cm), 20 (41 cm), 30 (39 cm) and 40 (42 cm) ml / liter of water had no significant effect on plant height. MOL treatment on bamboo shoots M2 treatment (20 ml / liter of water) was the best concentration to improve the agronomic characteristics of peanut in acid soils [7]. The best application of trichocompost fertilizer is 20 tons / ha for the growth of peanuts [8]. That dosage of phosphate fertilizer 120 g / ha and chicken manure 15 tons / ha gave interactions on flower growth, gynophores and number of pods at each observation age but did not interact with plant height parameters, number of leaves and number of branches [9].

3.4. Intercropping peanuts and corn in rainfed rice fields

The intercropping system in Nogosari District is well known to farmers with commodities of peanuts and Unyil corn in rainfed rice fields during planting season III. Whereas in dry land this planting system was carried out during the planting season I. The intercropping system technology for farmers only utilized the edge of the land for peanut beds, thus in reality, Jajar Legowo (a cropping method designed
to increase crop productivity through increasing plant populations and exploiting the crop edge effect; where planting is done by closing the plant spacing in rows and stretching the plant spacing) was used for corn.

The introduction of the applied technology was: a) Srikandi Kuning and Provit A varieties with farmer dosages and b) Srikandi Kuning and Provit A varieties with doses based on PUTK and agrodeco applications. Agrodeco application is carried out one week before planting.

**Table 4.** The yield of intercropping of peanut and corn in of Rembun and Jeron villages, Nogosari District

| Treatment                     | Ubinan Result (ton / ha) | Number of Plants | Fresh Weight of Bean Pod (gr) | Fresh Weight of Seed (gr) | Total of Seeds |
|-------------------------------|--------------------------|------------------|-------------------------------|--------------------------|----------------|
| **Rembun Farmers**            |                          |                  |                               |                          |                |
|                               | 6.1 a                    | 186.33 a         | 15,667 c                      | 10,000 b                 | 17,333 b       |
| **Recommendations of Rembun** |                          |                  |                               |                          |                |
|                               | 5.0 b                    | 191.33 a         | 15,667 c                      | 10,000 b                 | 16,667 b       |
| **Jeron Farmers**             |                          |                  |                               |                          |                |
|                               | 4.3                      | 137.67 b         | 24,000 b                      | 14,333 b                 | 22,667 b       |
| **Recommendation of Jeron**   |                          |                  |                               |                          |                |
|                               | 4.7 b                    | 106.00 c         | 43,667 a                      | 24,000 a                 | 37,333 a       |

The number of plants, fresh weight of pod, fresh weight of seed and the number of peanut seeds in Rembun Village in the farmers' intercropping treatment were not significantly different from the recommended intercropping treatment, but the ubinan results of the farmers' treatment were significantly different from the recommended treatment. The yield of intercropping peanut by farmers was higher than the recommended treatment. In Jeron Village, fresh weight of pod, fresh weight of seed and number of peanut seeds in the recommended intercropping treatment were higher, significantly different from the farmers' treatment. The yield of ubinan of recommended treatment was higher, significantly different from the farmers' treatment, although the number of plants in recommended treatment was less than that of farmers'. The ubinan yield of farmers' treatment in Rembun village was higher, significantly different from the yield of Jeron Village. Meanwhile, for the recommended treatment, the ubinan yield in Rembun village was not significantly different from that of Jeron Village. Therefore, the addition of composite corn commodity in rainfed rice filed can be accepted by farmers with the intercropping planting system. However, the acceptance of intercropping technology can last a long time if the availability of consumers, in this case redeemer, has entered the network of marketing institutional.

The intercropping pattern of gogo paddy and sweet corn did not affect the yield of gogo paddy. The intercropping pattern of gogo paddy and sweet corn affected the amount of light received by rice plants, plant height, number of tillers, weight of 1,000 grain and yield components of sweet corn, namely cob length, cob diameter and weight of sweet corn [10].

### 4. Conclusions and suggestions

#### 4.1. Conclusions

The cropping pattern in 100% rainfed rice field is paddy - paddy - palawija or paddy - palawija - palawija. Palawija is selected in accordance with market conditions and consumer needs. The cropping pattern which can be developed occurs in rainfed rice fields with the initial cropping pattern of paddy - palawija - fallow. In fallow conditions, farmers can be given a suggestion or counseling by planting other commodities or sticking with commodities in general. At the location of this activity, the leading
commodity is peanuts. The technology package and intercropping system are easily understood by farmers and are ready to be developed in Nogosari District.

4.2. Suggestions
Short and local varieties of Boyolali have the potential to be developed in Central Java and are ready to become outstanding varieties in Central Java.

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