The feasibility of cultiviting local rice Ratoon to anticipates drought

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Abstract. One of the advantages of ratoon technology was that the plant age becomes shorter so that it can utilize water in limited conditions. This study aimed to determine the feasibility (agronomy and economy) of cultiviting Rojolele local rice ratoon to anticipates drought. The study was conducted in the rice fields of Polaman, Argorejo, Sedayu, Bantul from May to December 2019. First planting as "Un-ratoon" treatment and second planting as "Ratoon" treatment. The un-ratoon and ratoon technology follows the Integrated Crop Management (ICM), but ratoon technology does not conduct seedbed and tillage. Morphological observations included plant height, number of productive tillers, leaf length, leaf width, panicle length, number of filled grains per panicle, number of empty grains per panicle, weight of 1,000 grains, weight of grain per hill and productivity. Observation data were analyzed using the Independent Sample T-test. An analysis of farming was carried out by calculating the B/C, R/C and MBCR (Marginal Benefit Cost Ratio). Ratoon cultivation technology was feasible to be developed because it has more than one BC ratio, RC ratio and MBCR value. With ratoon technology, period for crop maturity becomes shorter (45.66% decrease) so that it was a technological breakthrough to anticipate climate change (drought).

1. Introduction

The need for rice will continue to increase in line with the population growth rate. Based on the realization of rice production in the last 5 years, it is indicated that the growth rate of rice production has decreased and the cost of production per unit of land area has increased [1].

Given the recent climate change conditions continue to change and certainly make people even more restless. Anticipation of climate change needs to be anticipated properly and wisely by all parties, including researchers, academics, government and others. The increasing intensity of extreme climatic events (El-Niño and La-Niña) and seasonal irregularities as a result of global warming [2]. This condition can cause a shift in the rainy season. According to Subagyono and Surmaini [2], the shift in the rainy season can cause a) The dry season starts earlier with a longer period and the amount of rainfall is below normal, b) The beginning of the rainy season retreated with a shorter period with a lower and high intensity of rain. This situation causes "drought" and "flood". Therefore, it is necessary to make technological breakthroughs to anticipate climate change.

The use of drought-resistant and inundation-resistant varieties, early-maturity varieties is efficient in the use of water that accelerates the harvest period without reducing the quality and quantity of yields is a breakthrough technology that can be made to anticipate climate change (drought). Based on the research of Alfandi (2006) in Juanda [3], ratoon lowland rice was quite potential to increase rice production, especially in areas with limited water availability.
Ratoon rice cultivation technology was a breakthrough in location-specific rice cultivation technology based on local wisdom. Ratoon rice cultivation was a variant of ratoon cultivation technology, a stump after harvesting about 25 cm high, maintained for 7 to 10 days or left until new shoots emerge. If the shoots that come out are less than 70%, it is not recommended to do ratoon cultivation. If the shoots grow >70%, then cut back uniformly to a height of 3 to 5 cm, then they were properly maintained until harvest [1].

Ratoon rice was a rice plant that grows again after the remaining stems of the harvest are trimmed. Shoots will appear from the books in the soil and these shoots will release new roots so that the nutrient supply is no longer dependent on the old stem. These shoots can sprout again like regular transplanted rice [3]. The growth of shoots after cutting is strongly influenced by the availability of groundwater and at harvest time the groundwater should be in a state of field capacity. To compensate for the need for nutrients during the growth period of ratoon rice tillers, adequate fertilization is needed, especially nitrogen nutrients [3]. Efforts to increase rice production lead to an increase in land productivity through an increase in the harvest index from 2 to 3 or even 4 harvests in 1 year, this can be achieved by cultivating salibu rice [3]. Ratoon system increased rice yield 2 to 3 times of cropping index than the normal un-ratooning [4].

Ratoon rice was usually only used as forage for livestock, because the resulting grain is not economically profitable [5]. Ratoon rice cultivation is promising, as seen from the results obtained by farmers in Agam Regency in 2011, which was about 20% higher than from the first harvest [6]. Ratoon/salibu rice cultivation using the Batang Piman variety gives a yield of more than 6 t ha⁻¹, yield this was an increase (10% to 15%) over un-ratoon (transplanting) [7].

Ratoon rice cultivation was able to increase the harvest index (IP) ranging from 0.5 to 1 per year, increasing productivity: 3 to 6 t ha⁻¹ year⁻¹ of grain. Economically, ratoon cultivation saves costs of 60% for land preparation work and planting, 30% for production costs. Ratoon rice cultivation was about 45% more economical than transplanting/main crop [3]. Rojolele was a local rice that has a long plant age of approximately 150 days.

This local rice rojolele was liked by the community because of its purity and aroma, but nowadays it was increasingly rare for farmers to plant it because of the high age of the rice. If this continues, the local Rojolele rice will become increasingly rare and even extinct. Therefore the ratoon cultivation technology was a breakthrough so that the age of the rice becomes shorter and the local Rojolele rice remains sustainable. This was in accordance with Susilawati (2012) in Nuzul et al. [8] that the plant age of the ratoon plant was shorter than the parent plant because after the rice stalks are cut, they flower immediately and cause panicles.

Based on this, this study aims to determine the feseability (agronomic and economic) of cultivating Rojolele local rice ratoon to anticipates drought. The benefits of alternative technology for local rojolele rice in an effort to anticipate drought as a result of climate change (drought).

2. Materials and methods
The research was conducted in the paddy fields of Dusun Polaman, Argorejo, Sedayu, Bantul from May to December 2019. The tools and materials used were one unit of PUTS, hoes, plows. rojolele rice seeds, organic fertilizers, chemical fertilizers (NPK and Urea).

Morphological observations included plant height, number of productive tillers, leaf length, leaf width, panicle length, number of filled grains per panicle, number of empty grains per panicle, weight of 1,000 grains, weight of grain per hill and productivity. Observation data were analyzed using the Independent Sample T-test between Ratoon and Un-Ratoon/Main crop technologies.

Analysis of farming system was done by calculating the BC ratio (Benefit cost ratio), RC ratio (Revenue Cost ratio) and MBCR (Marginal Benefit Cost Ratio). BC ratio is to compare profit to cost, RC ratio compares revenue/revenue to cost. MBCR (Marginal Benefit Cost Ratio) was used to compare Un-ratoon/main crop cultivation technology with Ratoon cultivation technology.
Table 1. Technology components applied to ratoon and un-ratoon/main crop cultivation

| No. | Technology Components                      | Un-ratoon/Main crop | Ratoon                                                                 |
|-----|-------------------------------------------|---------------------|-----------------------------------------------------------------------|
| 1.  | Land preparation/Cutting the remaining stems of the harvest | Straw cleaning      | Spraying weeds (1-2 day after cutting = dac)                           |
|     |                                           |                     | Inundation (2-3) days                                                 |
|     |                                           |                     | Cutting the remaining stems (7-10 dac)                               |
| 2.  | Soil tillage                               | Soil tillage 2 x    | No tillage                                                            |
| 3.  | Nursery                                   | Absence             | No nursery                                                            |
| 4.  | Planting                                  | Transplanting       | No transplanting/no planting                                          |
| 5.  | Fertilization                              | Recommendations from Paddy Soil Test Equipment | Recommendations from Paddy Soil Test Equipment |
|     |                                           |                     | - Fertilization I = 40% dose, 15-20 dac (day after cutting)           |
|     |                                           |                     | - Fertilization II = 60% dose, 30-35 dac                               |
| 6.  | Thinning/embroidery                       | Absence             | Absence                                                               |
| 7.  | Weeding                                   | Standard of Plant Pest Organisms | Standard of Plant Pest Organisms                                    |
| 8.  | Pest control                               | Principles of Integrated Pest Management | Principles of Integrated Pest Management |
| 9.  | Harvest determination                      | Physiologically mature | Physiologically mature                                                |

If MBCR = 1, it means that the introduced improved technology (Ratoon) does not provide a significant additional revenue compared to those without improving farmer habits (Un-ratoon). If MBCR >1, it means that the introduced Ratoon cultivation technology package was feasible to be developed by farmers in that area. In accordance with Malin [11] that the decision to adopt a new technology is feasible if the MBCR >1. This means that the additional revenue obtained from the application of new technology must be greater than the additional cost. Marginal Benefit Cost Ratio (MBCR) can be used to measure the feasibility of new/ introduced technology compared to farmer technology [9-11]. Which can be formulated as follows [1-2]:

\[
MBCR = \frac{\text{gross revenue of } B - \text{gross revenue of } P}{\text{Total cost of technology } B - \text{Total cost of technology}} 
\]

Information: B = new technology - ratoon, P= farmer technology - un-ratoon; 
B/C > 1 = feasible, MBCR > 1 feasible

\[
\frac{\text{R/C}}{\text{Total cost production (Rp)}} = \frac{\text{Total revenue (Rp)}}{\text{Total cost production (Rp)}} 
\]
3. Results and discussion
The results of the agronomic data analysis of the two sample populations using the t-test show that there was a significant difference between the Ratoon and Un-ratoon technologies on number of productive tillers, number of filled grains per panicle, weight of 1,000 grains, weight of grain per hill, age of harvest, production costs and productivity, this was indicated by the t-stat value which was greater than the t-table (t Critical two-tail).

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The variables of plant height, leaf length, leaf width, panicle length, number of filled grains per panicle were not significant between ratoon and un-ratoon. However, all observed variables decreased in ratoon cultivation technology (table 2), except for plant length and the number of empty grain per panicle increased. The increasing percentage of empty grain per panicle in ratoon treatment in this study, because the K element only comes from NPK fertilizer, KCL fertilizer was not applied to ratoon and un-ratoon treatments. Potassium elements needed by rice plants in large quantities exceed the need for nitrogen nutrients [13]. Application of potassium fertilizer (K) resulted in a higher percentage of full grain compared to rice plants without K fertilization [14]. Potassium fertilizer stimulates root growth, improves grain quality and increases plant resistance to pests and diseases [15]. It can also be seen that there was a decrease in the quality of unhulled rice (1,000 grains weight), which has an impact on decreasing productivity in the cultivation of rojolele rice ratoon. Fertilizer given to the main crop/un-ratoon, will have an impact on the ratoon that grows next. Several studies have shown that the growth of ratoon highly depends on the composition and dosage level of fertilizer given [16]. Percent decrease in production costs = 37.66%, plant age = 45.66% and productivity only decreased 16.96%.

Table 2. Results of analysis of morphological components and technology costs of ratoon and un-ratoon on local rice rojolele with t test.

| No. | Variable                                      | Un-ratoon | Ratoon    | Significant | % Reduction |
|-----|----------------------------------------------|-----------|-----------|-------------|-------------|
| 1   | Plant height (cm)                            | 165.5     | 163.33    | 0.29        | 1.31 (D)    |
| 2   | Number of productive tillers                 | 20.67     | 13.67     | 0.002*      | 33.87 (D)   |
| 3   | Leaf length (cm)                             | 44.0      | 45.08     | 0.34        | -2.45 (I)   |
| 4   | Leaf width (cm)                              | 38.83     | 36.08     | 0.47        | 7.08 (D)    |
| 5   | Panicle length (cm)                          | 1.34      | 1.33      | 0.01*       | 0.75 (D)    |
| 6   | The number of filled grains/panicles         | 125.42    | 100.08    | 0.03*       | 20.2 (D)    |
| 7   | The number of empty grain/panicles           | 32.33     | 41.08     | 0.19        | -27.06 (I)  |
| 8   | Weight grain/clump (g)                       | 45.26     | 30.55     | 0.003*      | 32.5 (D)    |
| 9   | Weight of 1,000 grains (g)                   | 28.83     | 28.46     | 0.071*      | 1.28% (D)   |
| 10  | Plant age                                   | 149.6     | 81.3      | 0.0002*     | 45.66 (D)   |
| 11  | Production cost (input + labor 1,000 m²)     | 2,205,500 | 1,375,000 | 0.0002*     | 37.66 (D)   |
| 12  | Productivity (kg 1,000 m²)                   | 589.75    | 489.75    | 0.0002*     | 16.96 (D)   |

Information: D = Decrease  
I = Increase

Net profit (Rp)  
\[ \frac{B/C}{\text{Total cost production (Rp)}} \]  
(3)
It can be seen in table 2 that the harvest age of Rojolele rice with the ratoon cultivation technology has decreased to 45.66%, meaning that ratoon cultivation can increase the harvest index because it no land cultivation, no nurseries and no planting, so the production time period for crop maturity becomes shorter. Susilawati (2012) in Nuzul et al. [8], that the plant age of the ratoon plant was shorter than the parent plant because after the rice stalks are cut, they flower immediately and cause panicles. Ratooning does not require additional new seeds [17,18]. In addition, ratoon cultivation can shorten the life span by reaching 45.66% (table 2), so that it can be efficient in using limited water in case of drought.

| No | Description of activities | Unit | Total | Price | Total cost |
|----|----------------------------|------|-------|-------|------------|
|    | Material                  |      |       |       |            |

A. Seed  
1. kg 10 20,000 200,000 0
2. kg 200 700 140,000 140,000
3. kg 20 7,000 140,000 140,000
4. kg 25 14,000 350,000 350,000

Total production input 830,000 630,000

B. Labor  
1. Pruning/cutting straw  
2. Seedbed/nursery  
3. Tillage  
4. Planting  
5. Weeding  
6. Harvesting  

Total costs labor 1,375,000 750,000

C. Total costs (input + labor) 2,205,000 1,380,000

E. Total Revenue  
1. Production (un-ratoon/main crop)  
2. Production (ratoon)  
3. Benefit  

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Table 3. Farming system analysis of ratoon and un-ratoon cultivation on rojolele rice

Ratooning can reduce production costs by up to 37.66% therefore it can increase farmers' income. This was in accordance Juanda [3], ratoon rice cultivation was about 45% more economical than transplanting cultivation/un-ratoon. Although this local rojolele rice ratoon experienced a decrease in productivity = 16.96%. The results of farming system analysis is presented in table 3.

Table 3 shows that the value of the RC ratio is calculated by comparing the amount of revenue with the total costs incurred. The RC ratio value of the two technologies is 5.35 (Un-ratoon technology) and 7.10 (ratoon technology). This value indicates that the two technologies are profitable to operate because the RC ratio value obtained is more than one. Of the two technologies, the highest RC Ratio value is owned by ratoon technology.
The value of BC ratio is measured by comparing the net profit with the total production cost. The BC ratio values for the two technologies were 4.35 (un-ratoon) and 6.10 (ratoon). This shows that although both types of technology are profitable, ratoon technology has a greater BC Ratio value than un-ratoon technology. Thus, the results of this study indicate that of the two technologies that were most feasible to develop for local rice farming, rojolele was the “ratoon technology” because it has a high level of profit as evidenced by the RC Ratio value and has a BC ratio value of more than 1. As stated by [16] that if the R/C ratio of the agro-industry business was >1, then the business was profitable and if the B/C ratio was >1, then the business was feasible to develop.

The MBCR value illustrates the amount of additional revenue generated by each additional unit of input issued as a result of applying introduced technology (ratoon). Based on the MBCR value (table 3) = 2.42, the technology change from un-ratoon to ratoon (introduction) was feasible (MBCR >1). Un-ratoon technology to ratoon technology (introduced technology) was able to provide a total additional revenue that was greater than the total additional cost incurred and that was profitable for farmers, assuming stable prices and commodities can be absorbed by the market.

4. Conclusions
Ratoon cultivation technology is feasible to be developed because it has more than one BC ratio, RC ratio and MBCR value. With ratoon technology, period for crop maturity becomes shorter (45.66% decrease) so that it was a technological breakthrough to anticipate climate change (drought).

Acknowledgments
Thanks and appreciation to Mr. Marjan, who has applied salibu/ratoon cultivation to rojolele rice

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