The application of the ‘Jarwo Super’ component to increase the cropping index of rice fields in the special capital region of Jakarta-Indonesia

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Abstract. Jakarta, the nation’s capital of Indonesia, has 414 hectares of rice fields. The fields generally owned by developers that are not been used/idle land. In general, the existing cropping index of the land is only 1-2 which has potential to be improved. The main of this research was to obtain a model of agricultural technology innovation package to increase rice productivity and field cropping index in Jakarta through the application component of ‘Jajar Legowo (Jarwo) Super’ technology. The observation data consisted of primary and secondary data on the characteristics of cropping patterns for a year. The data were processed using descriptive and economic analysis was tested based on the Revenue Cost Ratio (R/C). The results of research showed that the application package or component of Jarwo Super technology showed an increase in the planting index by 0.3-0.8 and also an increase in productivity ranging from 5 t/ha to more than 7 t/ha. Based on the R/C analysis, the application component of Jarwo Super’s technology package increases the cropping index from 1.83 to 2.32. It means that the introduced cultivation technology can improve farm efficiency every planting season and increase farmer income every year.

1. Introduction
The pressure of the rice production system is getting heavier and more complex over time. The reduction in area and the degradation of irrigated land function, directly and indirectly, are serious threats to the stability of the national food supply. Extensification efforts to increase food production, especially rice, are not easy. Therefore, an intensification effort is needed, one of which is by increasing the cropping index.

Even though Jakarta is not an agricultural development area, in reality there are areas used for food crop development. It is known that North, East and West Jakarta are areas that have rice fields with the largest raw land area in North Jakarta, amounting 414 hectares in 2019 [1]. Most of the land is idle land owned by developers, with water sources coming from irrigation channels and some are rainfed rice fields. In general, the existing cropping index of the land in Jakarta is only 1-2 which has potential to be improved.

Technological innovation as a driving force for cultivation techniques in the field is always being updated, so that technology stagnation does not occur. In rice cultivation, technological innovation has developed rapidly, but its implementation in the field in an integrated manner has not been optimal in dry land and rainfed rice fields. The application of irrigation system technology innovation, rice
cultivation techniques, mechanization, and environmental manipulation interact and support each other to increase the productivity of land and rice plants.

Furthermore, efforts to increase the cropping index are possible with the availability of various innovations and technologies from Indonesia Agency for Agricultural Research and Development (IAARD/Bali). Another aspect of concern in increasing rice production is increased efficiency and environmental preservation, as these are related to production competitiveness. Therefore, it is necessary to select the appropriate use of technology in conducting cultivation. One of them is through Jajar Legowo Super technology. The Jajar legowo (intermittent planting) super of rice technology is an integrated rice cultivation technology based on intermittent row planting [2]. Jajar legowo or jarwo has long been known among farmers. In its implementation in the field, Jarwo Super rice technology uses: 1) quality seeds of new superior varieties with high yield potential; 2) biodecomposers during soil processing; 3) biological fertilizers as seed treatment and balanced fertilization; 4) control techniques plant pests (OPT) in an integrated manner; and 5) agricultural machinery, especially for planting and harvesting. Base on the fact, it is necessary to assess the application of component of ’Jarwo Super’ technology as a model of agricultural technology innovation package to increase rice productivity and field cropping index in Jakarta.

2. Methodology
This activity was carried out using a survey approach to obtain primary and secondary data, especially data related supporting conditions to the development of rice cultivation in Jakarta. The implementation of the rice and secondary crops cultivation technology package was carried out in a participatory manner in the cooperator group.

2.1. Socialization and coordination in determining co-operator farmer groups
Socialization, coordination and synchronization activities were carried out between AIAT Jakarta and related agencies and groups of prospective cooperators. These related agencies include: the Jakarta Regional Office and Sub-Department of Food Security, Maritime Affairs and Agriculture; potential cooperator groups; and the Indonesia Center of Agricultural Technology Assessment and Development (ICATAD). Further socialization was carried out to the selected cooperator groups, namely in the form of submitting a more detailed activity implementation plan related to the implementation stages based on the technical guidelines that had been prepared.

2.2. Baseline survey
Baseline survey activities were carried out in order to identify and make an inventory of existing conditions. This activity carried out by quick survey methods and field checks which included desk studies, namely compilation of supporting data and field surveys. The data identified included the location identity, the existing conditions of using rice cultivation technology, as well as irrigation sources and infrastructure. The survey locations in this study included West, East and North Jakarta. If the entire area of available irrigation water services can meet water needs for two or three growing seasons (GT), then this technology support is said to be able to increase the IP and productivity of existing rice.

2.3. Assesing the demonstration plot for the implementation of Jarwo Super component
This technology innovation application activity was based on data from an inventory and identification of land use and infrastructure and water management. Previously, the application of technological innovation was carried out in a stretch that could be served by the infrastructure and available water management. The components in the Jarwo Super technology package that were implemented include: (1) Use of organic fertilizers as basic fertilizers. The basic fertilizer used can be in the form of manure or compost. In this activity, the basic fertilizers used are cow manure (1 t/ha) and straw residue which is assisted by accelerated degradation using a consortium of degrading microbes. Manure used is 1 t / ha; (2) The use of a consortium of microbes that degrade organic matter (straw), namely the M-Dec
product. The straw which is the residue of rice cultivation activities from the previous planting season is processed into compost with the help of degrading microbes; (3) The use of new superior varieties (VUB), particularly Balitbangtan products, which are adaptive to site conditions. VUBs introduced into Jakarta area include Inpari-20, 30, 31, 32, 33, 35, 42, and Inpari-43; (4) Use of biological fertilizers as seed bioprimer, namely by utilizing a consortium of growth-promoting microbes. In this case, IAARD products in the form of Agrimeth are also used; (5) The use of legowo row planting systems, in the form of Legowo 2: 1, 4: 1, and legowo more than 4: 1. This legowo making system uses a tool in the form of a tick; (6) Fertilization is based on the results of existing nutrient quality measurements, namely using the rice soil test (PUTS), and based on the conditions of plant development using a leaf color chart (BWD); (7) Use of an integrated pest control system, especially by utilizing environmentally friendly plant-pests control materials. In this case, a botanical pesticide, a product of IAARD in the form of Bio Protector; and (8) The use of agricultural machinery that helps accelerate the cultivation process, from tillage to post-harvest.

All locations employed nearly all of the components of the technology package. However, there were several modifications or adjustments to the application of each component of the technology package.

2.4. Data analysis
The data observed were grain yield during the rainy season (RS) and dry season (DS). In addition, data collection on land area and rent, the amount of production input used (seeds, fertilizers, pesticides, etc.), the number and wages of labor, the amount and price of production produced, other costs incurred during planting, and farmers' perceptions of the produced jarwo super technology.

Data analysis was carried out quantitatively and qualitatively on jarwo super and farmer technology. To determine the level of financial feasibility of farmer cultivation technology and introduced technology, AIAT Jakarta is approached with a balance analysis of revenues and costs or R/C ratio.

3. Results and discussion

3.1. Socialization, coordination, and baseline result
The results of outreach and coordination activities indicate that there were several areas that potential for activities, including: Jakarta, West Jakarta, East Jakarta and North Jakarta. Based on data baseline survey, the type of rice fields cultivated by farmers was simple irrigation with water from rivers, which was channeled through secondary and tertiary channels. The frequency of planting was 1-3 times per year, where the growing season (GS) I was generally carried out in January / February, GS II in May / June, and GS III in September / November. The planting system was still conventional, according to the habits practiced by farmers from their home areas, namely monoculture with a tile planting system. In Jakarta, not all farmers planted simultaneously, especially in the North Jakarta area. In general, this is related to the availability of water, labor, and agricultural machinery.

The variety mostly used by farmers was Ciherang, followed by Sidenuk in North Jakarta, Kemuning in East Jakarta, and Cibatu in West Jakarta. The rest, depended on the taste and availability of farmer seed stocks. The reasons for farmers using the varieties mentioned above were because of their relatively short age, the number of tillers, high yields, and easily sold or liked by the community. The seeds planted by farmers came from seed traders, other farmers, or from the government, and were usually used two to five times the derivative of planting. In addition, it is known that in general, the water resources in the Jakarta area are quite possible to be utilized. However, because the existence of this water source is basically not intended as a means of irrigating rice cultivation land, coupled with the land ownership status which is generally an idle land owned by the developer, the water resources management cannot be carried out optimally.
3.2. Assessing the demonstration plot for the implementation of Jarwo Super component

Activities coordination activities and location surveys were carried out in several locations, including East Jakarta, West Jakarta and North Jakarta. The results of coordination with the local government, in this case the KPKP sub-agency, determined the locations used as technology show windows, including in the Marunda Jaya farmer group (North Jakarta), as well as the Java Indah and Hizbul Waton (West Jakarta) groups. A summary of the results of the activities is shown in Table 1.

In general, the use of VUB had increased the productivity and production of rice carried out in GS I. There was a tendency for an increase in rice productivity in the Marunda Jaya group by 1.5 times the average annual. However, in GS II plant productivity decreased slightly, which was caused by weather factors that tended to be more supportive of pest development. GS III, which was planned to be continued to cultivate advanced commodity crops, cannot be implemented in this location because farmers did not dare to plant as they were sure that the cultivated land is prone to flooding. GS II ended in November 2018. However, until the end of December 2018, it was found that the land was relatively safe from flooding, as previously feared.

Table 1. The results of implementing the components of the cultivation technology package on cropping index characteristics and rice productivity at the demonstration plot locations

| Descriptions                     | Marunda Jaya Group (sub distrik Marunda, district Cilincing, North Jakarta) | Jawa Indah Group (sub distrik Semanan, district Kalideres, West Jakarta) | Hizbul Waton Group (sub distrik Pegadungan, district Kalideres, West Jakarta) |
|----------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Introducing Variety             | Inpari 20, 30, 31, 32, 33, 35, 42, dan 43                                  | Inpari 20, 30, 32, 33, 42, dan 43                                       | Inpari 32 dan 33                                                            |
| Growing season                  | GS I dan GS II                                                               | GS II dan GS III                                                          | GS III dan GS IV                                                            |
| Cropping index existing         | 2.0                                                                         | 2.5                                                                       | 2.5                                                                         |
| Cropping index after introduction technology | 2.0 (no continued by farmer)                                                 | 2.8                                                                       | 3.3                                                                         |
| Provitas existing               | 5-6                                                                         | 4-5                                                                       | 4-5                                                                         |
| Provitas after introduction technology | 5-8                                                                        | 7-8                                                                       | 7-8                                                                         |
| Crop pattern index existing     | Rice-rice                                                                   | Rice-rice                                                                | Rice-rice                                                                  |
| Crop pattern index after introduction technology | Rice-rice-(potential rice)                                                  | Rice-rice-rice                                                           | Rice-rice-rice-(incidental rice)                                           |

The Jarwo Super technology that was applied basically acceptable to co-operator farmers, especially the application of the legowo row planting method. Farmers admitted that the use of legowo row facilitate plant maintenance. However, other applications of the jarwo super component could not be applied sustainably by farmers. In GS II, the Inpari-30 variety was the choice of varieties developed by co-operator farmers. Meanwhile, based on the results of GS II, farmers wanted to continue using Inpari-30 and Inpari-33. It is known that Inpari-30 has a fluffier taste of rice and its productivity is quite good in the area while Inpari-33 admitted by farmers tends to be resistant to the presence of brown planthopper (WBC).
Based on information from farmers, the use of organic fertilizers as basic fertilizers was somewhat less desirable. This is due to the tendency for weeds to grow more in the fertilized land than without fertilized using manure. However, farmers also admitted that in general the use of this basic fertilizer provides a better and stronger plant performance at the beginning of its growth. Likewise with the use of a consortium of microbes that degrade organic matter (straw), it was also recognized by farmers that it has an effect on better land conditions, however the availability of labor is also a special consideration for farmers to apply this technology component.

Farmers also admitted that using biological fertilizers in the form of a consortium of growth-promoting microbes had an effect on spurring seed growth. However, farmers also did not feel this component was the main component. It is assumed that the effect of this biological fertilizer component will be felt by users/farmers in a longer period of time, especially in relation to the efficiency of fertilizer use. However, due to the fact that the assessment has only been carried out for two growing seasons, further observations are needed on the effects/impacts of the use of biological fertilizers. Based on the results of existing nutrient quality measurements using PUTS, the availability of nitrogen and phosphorus in the land in Marunda was low. Thus, the use of nitrogen fertilizers, either singly or in a compound would be better if increased which similar to Husnain et al. [3] report. The use of vegetable pesticides from IAARD in the form of Bio Protector was also quite attractive to farmers. It is hoped that the socialization of pesticide use that is environmentally friendly can continue to be implemented and developed.

**Table 2.** The analysis of rice cultivation technology farming with component of jarwo super technology and farmers in Marunda Jaya group (North Jakarta)

| Descriptions | Jarwo Super Tech. (GS I) | Jarwo Super Tech. (GS II) | Farmer Tech. (GS I) |
|--------------|--------------------------|---------------------------|---------------------|
| I. Variable Cost (A+B+C) | 13,321,000 | 13,521,000 | 13,521,000 |
| A Production Cost | 2,956,000 | 2,956,000 | 2,950,000 |
| • Seeds | 150,000 | 150,000 | 260,000 |
| • Fertilizer | 2,500,000 | 2,500,000 | 2,025,000 |
| • Pesticide | 250,000 | 306,000 | 665,000 |
| B Labor | 6,420,000 | 6,420,000 | 9,060,000 |
| C Rent | 4,145,000 | 4,145,000 | 4,145,000 |
| II. Fixed Cost | 85,000 | 85,000 | 85,000 |
| D Depreciation of Equipment | 85,000 | 85,000 | 85,000 |
| III. Total Cost (I+II) | 13,406,000 | 13,606,000 | 16,240,000 |
| IV. Revenue, Profit, R/C | 32,760,000 | 32,760,000 | 27,000,000 |
| E Revenue | 19,354,000 | 19,154,000 | 10,760,000 |
| F Profit | 2.44 | 2.41 | 1.66 |

The results of the analysis of costs and revenues from lowland rice farming in Marunda Jaya show that the revenue generated in rice cultivation using jarwo super technology was higher than farmers' cultivation technology, namely Rp. 32,760,000, compared to Rp. 27,000,000, both for GS I and GS II. This has an effect on the profits generated by using Balitbangtan technology, which is almost two times farmer technology’s profit. The resulting revenue and cost balance were also higher, namely 2.44 in GS I and 2.41 in GS II while using farmer technology the resulting ratio is only 1.66 (Table 2).

Similar to the conditions of the demonstration plot at the North Jakarta, the location in West Jakarta also implemented the jarwo super system to carry out innovation insights and to increase its gardening
Activities in the North Jakarta location that also using VUB had increased productivity and crop production (Table 1 and 3). The pilot was carried out in the Java Indah location at GS II and III. The commodity being developed is still paddy. This is due to the abundant availability of water. However, to make a separate water reservoir is rather difficult because permission is required from the land owner who is a developer. Likewise, in the land conditions in Hizbul Waton, demonstration plots were conducted at GS III, which also ended in November, and then continued to develop independently by farmers in the next GS directly in December. The use of jarwo super technology also has an impact on increasing rice production. It was known that rice fields in West Jakarta are an area that is quite vulnerable to WBC attacks. Inpari-33 is known to be real in increasing rice productivity in Hizbul Waton, as well as Inpari-32. However, the VUB-VUBs are still classified as vulnerable to bird attack. It is also known that the conditions for bird pest infestation in West Jakarta are quite high.

The results of the analysis of costs and revenues from lowland rice farming in Java Indah show that the revenue generated in rice cultivation using jarwo super technology at GS II was the same as farmer cultivation technology while farm revenue at GS III was higher. This is because the amount of production using jarwo super GS III technology with the same farmer technology was 6 tons, while the production using jarwo super technology at GS III was higher, which is 8 tons. This has an effect on the profits generated by using jarwo super technology as GS II was lower than farmers’ technology because the costs incurred by using jarwo super technology were also higher. The revenue and cost balance (R / C ratio) generated using jarwo super technology at GS II was only 1.62, at GS II was 2.16, while using farmer technology was 2.01.

**Table 3.** The analysis of rice cultivation technology farming with component of jarwo super technology and farmers in Jawa Indah group (West Jakarta)

| Descriptions             | Jarwo Super Tech. (GS II) | Jarwo Super Tech. (GS III) | Farmer Tech. (GS I) |
|--------------------------|---------------------------|---------------------------|---------------------|
| I. Variable Cost (A+B+C) | 15,486,000                | 15,486,000                | 12,435,334          |
| A Production Cost        | 3,236,000                 | 3,236,000                 | 2,638,334           |
| • Seeds                  | 150,000                   | 150,000                   | 325,000             |
| • Fertilizer             | 2,600,000                 | 2,600,000                 | 1,946,667           |
| • Pesticide              | 486,000                   | 486,000                   | 366,667             |
| B Labor                  | 7,950,000                 | 7,950,000                 | 9,380,000           |
| C Rent                   | 4,300,000                 | 4,300,000                 | 417,000             |
| II. Fixed Cost           | 85,000                    | 85,000                    | 85,000              |
| D Depreciation of Equipment | 85,000                  | 85,000                    | 85,000              |
| III. Total Cost (I+II)   | 15,571,000                | 15,571,000                | 12,520,334          |
| IV. Revenue, Profit, R/C |                           |                           |                     |
| E Revenue                | 25,200,000                | 33,600,000                | 25,200,000          |
| F Profit                 | 9,629,000                 | 18,029,000                | 12,679,666          |
| G R/C                    | 2.44                      | 2.41                      | 2.01                |

The results of the analysis of costs and revenues from lowland rice farming in the Hisbul Waton show that the revenue generated in rice cultivation using jarwo super technology was higher than farmer cultivation technology. The benefits obtained by using jarwo super technology were much higher than using farmer technology. The balance of revenue and costs generated by using jarwo super technology was also higher, namely 2.89 at GS I and 1.83 (Table 4). This shows that the jarwo super technology provides better results than the farmer technology in the Hisbul Waton. That is similar with report by some researcher [4,5,6,7,8].
Table 4. The analysis of rice cultivation technology farming with component of jarwo super technology and farmers in Hizbul Waton group (West Jakarta)

| Descriptions                      | Jarwo Super Tech. (IDR) | Farmer Tech. (IDR) |
|-----------------------------------|-------------------------|--------------------|
| I. Variable Cost (A+B+C)          |                         |                    |
| A Production Cost                 | 12,706,000              | 9,083,667          |
| • Seeds                           | 2,906,000               | 2,203,667          |
| • Fertilizer                      | 150,000                 | 325,000            |
| • Pesticide                       | 2,270,000               | 1,238,667          |
| B Labor                           | 486,000                 | 640,000            |
| C Rent                            | 5,500,000               | 5,280,000          |
| II. Fixed Cost                    |                         |                    |
| D Depreciation of Equipment       | 4,300,000               | 1,600,000          |
| III. Total Cost (I+II)            | 12,791,000              | 9,168,667          |
| IV. Revenue, Profit, R/C          |                         |                    |
| E Revenue                         | 85,000                  | 85,000             |
| F Profit                          | 85,000                  | 85,000             |
| G R/C                             | 36,960,000              | 16,800,000         |
|                                   | 24,169,000              | 7,631,333          |
|                                   | 2.89                    | 1.83               |

4. Conclusion
The application of package or component of Jarwo Super technology showed an increase in the cropping index by 0.3-0.8 and also an increase in productivity ranging from 5 t/ha to more than 7 t/ha. Based on the R/C analysis, known that the application of component of Jarwo Super technology package increased the cropping index from 1.83 to 2.32. The introduced cultivation technology can improve farm efficiency every planting season and increase farmer income every year.

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