Prospect of development of 2:1 “Jajar Legowo” planting system technology in the development of rice area, Takalar District

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Abstract. Technology is one factor in increasing agricultural production capacity. The use of new technologies will increase the use of inputs, making it possible to achieve production and farm efficiency. The jajar legowo (double row) system is a technological engineering to obtain a plant population of more than 160,000 per hectare. The implementation of Jajar Legowo in addition to increasing the cropping population, is also able to increase the smooth circulation of sunlight and air around the pingir plants so that the plants can photosynthesize better.

Assistance in the application of engineering technology for the legowo row 2: 1 system was carried out in Panranuangku sub-district, Polut sub-district, Takalar district. The technology engineering of the legowo row 2: 1 system is supported by other technologies that are applied through pilot farming models (demfarm) at strategic locations in the development area that have fairly good access, which can be seen by the community in the assisted area. The selection of the demfarm location is determined together with the farmer groups, field officers / PLL and stakeholders involved so that it can be ascertained that the pilot farming model can represent the conditions of the development area to be built. The results of the assistance in the area of rice farming in irrigated rice fields in Takalar Regency, South Sulawesi, show that the development of the rice crop area has a large enough opportunity to be developed with the support of legowo row 2: 1 technology engineering and institutional innovation. The results of the assistance for the paddy farming area with a 2: 1 legowo row technology engineering planting system in the irrigated rice fields of Takalar Regency also provide understanding to the relevant agencies starting from the planned mentoring model to the implementation stages. The rice technology demfarm with the legowo row system technology engineering 2: 1 showed an increase in yield from 4-5 tonnes per ha (local productivity) to 7-8 tonnes per ha.

1. Introduction

The demand for food is increasing along with the increasing population, so the challenge for future agricultural development is how to provide food for the fulfillment of community food, industrial raw materials and energy which are increasing in number. For this reason, the progressive application of appropriate technology becomes an obligation. Innovative products and procedures in the business world provide opportunities for sustainable production [1].

The achievement of food security targets as part of national food sovereignty needs to be accompanied by increased production and self-sufficiency in rice, corn and soybeans. Operational
steps to increase rice, corn and soybean production can be carried out through two sources of production growth, namely increasing planting area and increasing productivity, namely: a) Increasing planting area through: new land printing, optimization of cropping index, utilization of abandoned land, intercropping; b) Increasing productivity, through the application of innovation and good cultivation technology (use of inputs according to recommendations, good cultivation maintenance, pest and DPI control), application of good harvests. One of the supporters that can provide a quick influence in increasing rice production is the support of innovation and technology [2].

Technology is one of the determining factors in the production process [3]. Technology is a key factor in increasing agricultural production capacity because technology is created through research activities and plays a role in increasing agricultural production and farmers' welfare. In the production process the application of new technology will increase the use of inputs, so that it is possible to achieve farm efficiency. Research with productivity is closely related which can be seen in one form of agricultural research output, namely if technology to increase productivity is disseminated to farmers and then applied so that there is an increase in productivity [4].

The application of technology to increase farmers' production and income needs to also be adjusted to the specific conditions of the location of the farming carried out by the farmers. The general description of the condition of agricultural businesses in Indonesia is still dominated by family farming, which amounts to 25,579 million agricultural households or about 50 percent of the total number of households in rural areas. The agricultural sector still absorbs about 39 million people, the largest of all economic sectors. Types of household activities are agricultural land users, mostly rice/palawija and plantations. Currently, the issue of land availability for food agriculture is still one of the main limiting factors for increasing food production and efforts to improve farmers' welfare. In such conditions, it is very natural that the carrying capacity of paddy fields in absorbing labor is limited. Most of the agricultural businesses that are cultivated still control land under 0.5 ha (small farmers), whose proportion tends to increase. It is estimated that the number of small-scale farmers (under 0.5 hectares) in 2045 will number around 19 million households, with the proportion still around 46 percent of the total agricultural households [5]. The Next [6] said that one of the challenges of agricultural research institutions is to find new technological breakthroughs that are affordable for farming farmers with limited land area.

South Sulawesi has an area of 653,946 ha of paddy fields, and based on the type of irrigation, it consists of 391,147 ha of irrigated rice fields, 262,799 ha of non-irrigated rice fields. Harvested area based on the type of food crop commodity, lowland rice covering an area of 995,335 ha with a province of 5.3 t/ha, upland rice covering an area of 48,695 ha with a province of 3.7 t/ha. Corn covering an area of 295,115 ha with a province of 5.2 t/ha, soybeans covering an area of 38,036 ha with a yield of 1.8 t/ha [7]. Based on this potential, South Sulawesi is a large national food producer and barn outside Java. South Sulawesi's rice production is mostly distributed to Eastern Indonesia (KTI). This role can still be increased based on the opportunity to increase production which is still quite large. In some areas and farmers can achieve production of 7 - 9 t/ha, while the results of the PTT study in South Sulawesi are between 6.5 - 8.3 t/ha [8]; [9]; [10], as well as the results of SL assistance -PTT in the form of display varieties that give yields reaching 10 t/ha [11]; [12].

One of the supporting factors for agricultural development is the development of an innovation system. Research and development is an inseparable part of agricultural development that has been successfully achieved by the Ministry of Agriculture so far. Some of the innovations include the creation of new superior varieties, cultivation technology, harvesting, post-harvesting and processing. The National Seed Innovation Sub-System has produced a variety of new varieties, especially rice. However, these new high yielding varieties (Inpari, Inpago, Inpara, and Hybrids) have not completely replaced the old superior varieties, because the dissemination function and the national seed system are not yet optimal. Meanwhile, the Sustainable Production Innovation sub-system has produced various outputs, especially technology for improving farming systems, such as improving plant spacing technology through the Jajar Legowo (Jarwo) system, and various other innovations [13].
According to [14] that in addition to increasing production and productivity through the use of farming inputs, it is also influenced by other factors such as: (1) access to public facilities and infrastructure (roads, irrigation facilities); (2) market institutions covering credit, labor, fertilizer markets, and output markets; (3) dissemination of agricultural information; (4) land tenure structures and other important resources (hand tractors and pumping wells); and (5) physical characteristics such as the type of climate and the social structure that supports it.

Given that one of the sources of growth in increasing production is through increasing productivity, namely by applying new technological innovations in the production process of farming so that there is an increase in production. One of the production technologies that have been produced by the Agency for Agricultural Research and Development is the jajar legowo rice planting system. The results of the application of the Legowo jajar system in Bajeng District, Gowa Regency on technically irrigated rice fields showed dry grain yields reached 8.50 t/ha, higher than the tile system at 6.36 t/ha [15]. Next [16], saw farmers’ perceptions of the jajar legowo technology that most of them agreed because it was proven that the jajar legowo planting system provided higher incomes than the farming system that farmers usually practiced. The results of the study by [17], that in the study of the application of jarwo super technology on lowland rice plants gave a better growth response and yield compared to rice cultivation without the application of jarwo super technology. Jarwo Super technology can increase rice productivity by 30%. Seeing the importance of the jajar legowo system technology to increase rice production, it is necessary to look at the prospects for developing the technology for the jajar legowo rice system in Takalar district.

2. Materials and methods
2.1. Basic principles and characteristics of components legowo line system technology
2.1.1. Jajar legowo planting system 2:1
The jajar legowo 2:1 system was adapted from [18], about the jajar legowo planting system produced by the Agricultural Research and Development Agency. The legowo system is a technological engineering to get a plant population of more than 160,000 per hectare. The application of Jajar Legowo in addition to increasing the crop population, is also able to increase the smooth circulation of sunlight and air around the periphery of plants so that plants can photosynthesize better. In addition, plants on the edge are expected to provide higher production and better grain quality, considering that in the jajar legowo planting system there is an open space of 25-50%, so that plants can receive optimal sunlight which is useful in the photosynthesis process.

The application of the legowo planting system is recommended to use a spacing of (25x25) cm between clumps in rows; 12.5 cm spacing in rows; and 50 cm as the distance between rows/aisles or written (25x12.5x50) cm. Avoid using very tight spacing, for example (20x20) cm, because it will cause the spacing in rows to be very narrow.

The 2:1 legowo planting system will produce a total plant population per ha of 213,300 clumps, and will increase the population by 33.31% compared to the tile (25x25) cm planting pattern which is only 160,000 clumps/ha. With this cropping pattern, the entire row of plants will get an insert plant.

![Figure 1. Jajar legowo cropping pattern](image)
2.1.2. Advantages of Jajar Legowo

According to [19], the legowo planting system is one of the components of PTT in lowland rice which, when compared to other cropping systems, has the following advantages:

1. There is a wider open space between the two groups of rows of plants that will increase sunlight entering each clump of rice plants thereby increasing photosynthetic activity which has an impact on increasing plant productivity.
2. This lined crop system makes it easy for farmers to manage their farms, such as: additional fertilization, weeding, pest and disease control (spraying). Besides, it is also easier to control rat pests.
3. Increase the number of plants on both sides for each legowo set, so that it has the opportunity to increase plant productivity due to an increase in population.
4. This lined crop system is also an opportunity for the development of a rice-fish production system (mina padi) or parlebek (a combination of rice, fish, and duck).
5. Increase rice productivity up to 10-15%.

With jajar legowo planting technology, the outermost row of plants provides a looser growing space as well as air circulation and better utilization of sunlight for planting. In addition, weed control and fertilization efforts can be done more easily. An understanding of the jajar legowo rice planting technology is important so that the benefits that will be obtained from its application will be more optimal.

2.2. Development of the legowo 2:1 system in the rice food area of Takalar regency

2.2.1. Application of the Legowo 2:1 Jajar System and Supporting Technology

The implementation of the 2:1 jajar legowo system is supported by other technologies that are applied through pilot farming models (demfarm) at strategic locations in development areas that have good access, which can be seen by the community in the mentoring area. The location of the demonstration farm is determined together with farmer groups, field officers/PLL and stakeholders involved so that it can be ascertained that the pilot farming model can represent the condition of the development area to be built. The introduction of technological model can represent the condition of the development area to be built. The introduction of technological innovations in the jajar legowo 2:1 system and its supporting technology through demonstrations is carried out in order to accelerate the arrival of technological innovations to the user level. Technological innovation is expected to significantly increase production and production quality. Technological innovations are recommended to support the implementation of the 2:1 row legowo system [20].
The innovation of rice production technology is displayed at the dem-farm location as follows:

The technological components supporting the Jajar Legowo 2:1 cropping system, which are applied include: New superior varieties of rice (Inpari 4, 9, 40, 42, 43), planting distance (25x12.5x50) cm, fertilizer (NPK 300 kg/ha, Urea 200 kg/ha); Agrimeth, Agrobiodekomp; Disease Pest Control with PHT concept; Panendengan Combine Harvester. With the application of Jajar Legowo 2:1 technology it gives higher results (28-40%) compared to outside demfarm. More can be seen in table 1 below.

Table 1. Technological components applied to dem-farm area and farmers outside dem-farm.

| No | Technology components | Dem-farm/ Cooperator | Outside Dem-farm/ Non Cooperator |
|----|-----------------------|-----------------------|---------------------------------|
| 1  | Variety               | Inpari 4, 9, 40, 42, 43 | Ciherang, Cisantana             |
| 2  | Planting Distance     | Legowo system 2:1 (25x12.5x50) cm | Tegel/square system |
| 3  | Fertilization         | - NPK 300 kg/ha     | - NPK 150 kg/ha |
|    |                       | - Urea 200 kg/ha    | - Urea 300 kg/ha |
| 4  | Agrimeth              | Agrimeth 250-500 gram per ha | Do not use |
| 5  | Agrobiodekomp         | Agrobiodekomp 1000-2000 gram perha | Do not use |
| 6  | Pest and Disease Control | Integrated Pest/Disease Management and Pesticides | Integrated Pest/Disease Management and Pesticides |
| 7  | Harvest               | Combine Harvester   | Combine Harvester                |
| 8  | Yield                 | 7-8 ton per ha     | 4-5 ton per ha                  |

3. Results and Discussion

The application of the 2:1 row legowo system with supporting technologies such as new high yielding rice varieties technology, spacing (25x12.5x50) cm, Agrimeth, Biodecomposer obtains a yield of 7-8.5 tons of GKP per ha. Farmers are very grateful for this assistance activity for the development of the rice area, the introduction of the 2:1 jajar legowo system technology with its supporting technology,
they can compare the productivity that has been obtained so far, the average production obtained so far is around 5 tons per ha. With this technology demonstration, they can have great hopes to increase their production by applying the rice cultivation technology with the 2:1 row legowo system shown in the assistance activities for the development of the rice area.

The results achieved are in line with the results of research by [17], that in the study of the application of jarwo super technology in lowland rice plants, it gave a better growth response and yield compared to rice cultivation without the application of jarwo super technology. Jarwo Super technology can increase rice productivity by 30%. Reports on the results of implementing the Legowo Jajar system in Bajeng District, Gowa Regency on technically irrigated rice fields show dry grain yields reaching 8.50 t/ha, higher than the tile system at 6.36 t/ha [15], [16]. Looking at the farmers' perception of the jajar legowo technology, most of them agreed because it was proven that the jajar legowo planting system provided higher incomes than the farming system that was usually done by farmers.

The integration of various technologies into a superior package generally has a fairly high success rate in its implementation. Jarwo Super technology which is a combination of several superior technology components consisting of jajar legowo cultivation technology, utilization of agricultural machinery, superior seeds, fertilization with optimal doses, utilization of decomposers in straw waste management, utilization of biological fertilizers in seed treatment and biopesticides for controlling organisms plant nuisance [21].

The level of implementation of jajar legowo 2:1 in mentoring locations can be seen, that the level of application has only reached 10%. While the supporting technology is the level of land management (52.90%), the use of superior varieties (55.10%), the accuracy of the planting schedule (90.29%), balanced fertilization and the use of organic fertilizers (30.50%), pest control (60.60%) (Table 2).

| No. | Description                                                                 | Proportion/Percentage (%) |
|-----|------------------------------------------------------------------------------|----------------------------|
| 1   | Level of application of land management technology                            | 52.90                     |
| 2   | Use of Superior Varieties                                                    | 55.10                     |
| 3   | Legowo planting system                                                       | 10.00                     |
| 4   | Accuracy of Planting Schedule                                                | 90.29                     |
| 5   | Balanced fertilization and use of organic fertilizer                         | 30.50                     |
| 6   | Control of Plant Pest Organisms                                              | 60.60                     |

Social Aspect
1. Farmers' participation in rat pest control
   39.00
2. Farmers follow the planting schedule
   90.29

Economic Aspect
1. Efficiency of using saprodi
   50.70
2. Farmers' actions in capital development
   20.50

3.1. Potential Support for Application of Jajar Legowo Technology
Potential use of agricultural land in Takalar Regency. Takalar is one of the rice food development areas in South Sulawesi which has quite potential land. In 2016 the land use for rice fields was 16,619 ha which was divided into 5,932 ha for irrigated rice fields and 10,687 ha for rainfed rice fields. The use of irrigated rice fields for planting twice a year is more than the use for planting once a year and three times a year, which is each planted twice a year for an area of 4,908 ha, planted once a year for an area of 146 ha and planted three times a year for an area of 878 ha.
Table 3. Agricultural land use in Takalar Regency 2016-2017

| No | Land Use  | Year 2016 |       | Year 2017 |       |
|----|-----------|-----------|-------|-----------|-------|
|    |           | One time  | Twice | >Three Times | Amount | One time  | Twice | >Three Times | Amount |
| 1  | Rice fields: | 146 | 4.908 | 878 | 5.932 | 0 | 5.056 | 1.025 | 6.081 |
| 2  | Irrigation | 9.189 | 692 | 806 | 10.687 | 9.295 | 5.748 | 1.831 | 16.874 |
| 3  | Rainfed   | 9.335 | 5.600 | 1.684 | 16.619 | 9.295 | 5.748 | 1.831 | 16.874 |

In 2017, the land use for rice fields was 16,874 ha which was divided into irrigated rice fields of 6,081 ha and rainfed rice fields of 10,793 ha. The use of irrigated rice fields to be planted twice a year is more than the use to be planted once a year and three times a year, which is each planted twice a year covering an area of 5,056 ha, planted three times a year covering an area of 1,025 ha. Then the use of rainfed rice fields for planting once a year is more than the use for planting twice a year and three times a year, which is each planted once a year with an area of 9,295 ha, planted twice a year for an area of 692 ha and planted three times a year for an area of 806 ha.

Especially in the North Polongbangkeng sub-district, the use of irrigated and rainfed rice fields can be seen in table 4. The use of land for irrigation and rainfed is almost balanced, namely irrigated rice fields with an area of 1,775 ha and rainfed rice fields covering an area of 1,914 ha. The use of irrigated rice fields to be planted twice a year is 1,639 ha, planted three times a year is 1,639 ha. Then the use of rainfed rice fields to be planted once a year is 1,914 ha, planted twice a year for an area of 1,639 ha and planted three times a year for an area of 136 ha.

Table 4. Agricultural land use in North Polombangkeng Sub-District, Takalar District, 2016

| No | Land Use  | One time | Twice | >Three Times | Amount |
|----|-----------|----------|-------|--------------|-------|
| 1  | Rice fields: | 0 | 1.639 | 136 | 1.775 |
| 2  | Irrigation | 1.914 | 0 | 0 | 1.914 |
| 3  | Rainfed   | 1.914 | 1.639 | 136 | 3.689 |
| 4  | Number of Rice Fields | 3.828 | 3.278 | 272 | 7.378 |

3.2. Cropping Pattern

Cropping pattern is a potential that can be developed. With a good cropping pattern, it will have an impact on good on-farm and off-farm activities, when to start planting to get good production and profits. If there is still an opportunity to increase IP by setting cropping patterns, it may be more appropriate to do so to increase production compared to other aspects that require more specific attention.

The existing cropping pattern is closely related to the availability of water resources. The rice field cropping pattern by planting rice 3 times a year has a water source from technical irrigation. While the cropping pattern with rice twice a year and once palawija has water sources from village irrigation. Likewise, the cropping pattern in rainfed rice fields the source of irrigation is partly from village irrigation and partly rainwater. The water source at the mentoring location comes from the Bissuwa Dam technical irrigation, North Polongbangkeng District. If the irrigation capacity can be increased again and the use of water is maximized by organizing groups, it will support the accuracy of cropping patterns in the mentoring locations.
According to [22], to improve the performance of irrigation management at the farmer level in order to achieve optimal rice farming production results, from the institutional aspect, the coordination and participation of farmers in P3A will be improved so that awareness for maintaining irrigation networks increases as well as communication between farmers and agricultural extension workers. Increased so that the use of irrigation will be in line with the increase in rice farming production.

3.3. Labor Availability

Residents in the development site generally do farming, and some have a side job in the form of carpentry. Those who have a side job as carpenters can manage their time working on the land and work as carpenters. During the rainy season and sufficient water is available, people go down to the fields to carry out their farming activities from land preparation to maintenance and harvesting. When viewed from the main employment field, more than half of workers in Takalar work in the agricultural sector. The high percentage of the population working in the agricultural sector is caused by geographically Takalar is an agricultural center area. Another thing is that the education of the workforce is relatively low, so it will experience obstacles in carrying out work in other sectors due to the lack of skills / skills possessed [23].

Figure 3. Irrigation rice planting pattern three times a year
Table 5. Employment Situation of Takalar Regency, 2015-2017

| Description            | 2015    | 2017    |
|------------------------|---------|---------|
| Workforce              | 119,736 | 137,745 |
| Job seekers            | 438     | 470     |
| Work                   |         |         |
| - Agriculture          | 114,895 | 130,960 |
| - Processing industry  | 46,547  | 50,819  |
| - Trade                | 13,742  | 11,338  |
| - Community services   | 21,268  | 31,058  |
| - Other                | 15,760  | 17,928  |
|                        | 17,578  | 19,817  |

Source: [23].

3.4. Constraints of the development of the legowo 2:1 jajar planting system in the assistance of rice food area of Takalar District

The method of planting the jajar legowo system is still relatively new in the community so that farmers find it difficult to use it. The spacing that is commonly used by farmers is the tile system while the recommended spacing is the 2:1 row legowo system (25x12.5x50) cm. When planting, farmers use hired labor who are not used to the jajar legowo method, so they must be supervised and controlled by farmers. Problem solving solutions need to be continued by providing motivation through more intensive guidance until farmers are accustomed and willing to apply the 2:1 row legowo planting method. The internal factors of farmers that are significantly related to the level of adoption of the jajar legowo 2:1 technology are the motivation to follow the jajar legowo 2:1 technology, the level of relative profit, the level of complexity and the level of convenience [24]. In areas with limited manpower, the application of jajar legowo can be supported by suitable planting tools such as the Jarwo Transplanter.

The obstacle faced by the application of supporting technology is the availability of superior varieties of rice seeds. This requires fostering and empowering breeders in collaboration with related parties with seed agencies, among others. Rats are still the main pest in the planting site, the eradication method used is still individual and the eradication is not timely. Eradication of rat pests is carried out at the time before rice is pregnant with rat poison. It is recommended that rat pest control be carried out in groups and on time, carried out before planting or during land processing, as well as sanitation of the surrounding environment.

Pests that still often attack are planthoppers and crackle so it is advisable to conduct regular observations in collaboration with pest and disease officers, in addition to using crackle resistant varieties.

4. Conclusions

a. The results of the assistance for the rice farming area in irrigated rice fields, Takalar Regency, South Sulawesi, show that the development of the rice plantation area has a large enough opportunity to be developed with the support of technology engineering, jajar legowo 2:1 and institutional innovation.

b. The results of the assistance in the rice farming area with the 2:1 jajar legowo technology engineering planting system in irrigated rice fields in Takalar Regency also provide understanding to the relevant agencies. They understand the activities carried out starting from the planned mentoring model to the implementation stages. They already know that this activity is carried out well if there is good synergy between agencies, because in the end the output of this activity in the form of a model for assisting agricultural areas is expected to be continued by the regions.
c. The demonstration of rice technology using the 2:1 jajar legowo system engineering technology showed an increase in yield from 4-5 tons per ha (local productivity) to 7-8 tons per ha.

d. Synergy of South Sulawesi AIAT and local government agencies began to occur in activities to increase rice production side by side at the location of assisting rice areas with technological engineering of the 2:1 jajar legowo system.

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