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Research article

Performance and community acceptance of paddy management with balanced input cultivation technology in Kebonagung Village Madiun East Java Indonesia

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A B S T R A C T

By integrating balanced rice growing technology components, getting rice organoleptic tests from the rice produced, and learning about the community acceptability of the applied technology components, this study seeks to ascertain the growth response and NSV production of specific and site-specific rice. The study was carried out in rice paddies. five different types of technology bundles in a randomized group trial design. Each treatment unit and replication in the five iterations of the experiment used 0.3 ha. Acceptance in the community using a survey approach with fifty participants. The results indicated that the Inpari 42 and Inpari 45 seedlings developed the tallest plants between 77 and 81 days after planting. Inpari 32 had the most tillers, which was the same as Inpari 42 and Pamelen. Pamelen yielded the most productive tillers and the least amount of non-productive tillers. The largest plant height was measured 98–102 days following the Inpari 42 seedlings, while the highest number of tillers were found in Pamelen, Inpari 32, and Inpari 42. Inpari 42 has the widest flag leaf area. The most abundant grain component produced by Inpari 42 is the number of grains per panicle and the full grain per panicle. The highest production is produced by Inpari 32. The panelists' favored rice varieties were Inpari 32, Inpari 42, and Inpari 45 based on the rice's organoleptic test results (color, aroma, taste, and texture). Inpari 32, Inpari 45, and Inpari Nutrizinc rice had greater brightness. Inpari 45 is yellowish, and Pamelen is quite red. Pamelen and Inpari Nutrizinc are the same. The high adoption rate of 8766 % and the rapid diffusion of applied technology to nearby villages and other regions indicate that the community has a very positive attitude toward technology.

1. Introduction

Rice is a significant, strategic, and important food crop commodity in Indonesia. According to data from the Ministry of Agriculture, 4.8 million hectares were planted with rice, and 81.3 million tons of dry-milled grain were produced, leaving a 17.4 million tons production excess [1]. When rice is cultivated in paddy fields as opposed to marginal, dry, or swampy terrain, it produces rice with higher productivity. Currently, Indonesia's lowland rice productivity is ranked third in Asia, behind China and Vietnam, and tenth out

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of thirty main rice-producing nations worldwide [2].

Even though Kebonagung Madiun Village is among the top ten rice-producing regions in East Java, its output pales in comparison to that of Lamongan (873,786 tonnes), Ngawi (829,468 tonnes), and Bojonegoro (737,398 tonnes) [3]. Due to the usage of poor quality, unlabeled seeds that are dispersed among farmers in farming groups from the previous season's rice crop, rice production is still relatively low (453,541 tons). Seed viability and vigor are not uniform when low-quality seeds are used. As a result, both the quality and quantity of the rice grains produced are poor.

One technical advancement that may be counted on to raise rice productivity and output is new superior varieties (NSV) [4]. It is envisaged that farmers would have many options when it comes to rice NSV, which agricultural research and development agencies are still producing, as an alternative to replacing outdated varieties whose productivity has started to fall or are more vulnerable to insect assaults. The productivity and revenue of lowland rice producers can both rise with the usage of superior varieties [5]. Through the Rice Research Center, The Agricultural Research and Development Agency launched more than 100 new superior rice varieties between 2007 and 2020 that were tailored to specific regions for all agroecosystems [6].

Agricultural research and development agency has introduced new superior rice varieties that are site-specific and tailored to particular agroecosystems and sociocultural contexts. The new superior types of special rice, including Pamelen, which is redder and fluffier, and Inpari Nutrizinc, which has a higher zinc concentration, both offer unique qualities. Eight health benefits of Pamelen rice have been studied by doctors. The advantages of pamelen rice for the body include: 1) preventing heart disease; 2) lowering cholesterol; and 3) combating free radicals. 4) reduces levels of blood sugar 5) lowers the chance of obesity; 6) preserves skin health; 7) conquers asthma; and 8) preserves bone health. One of the causes of stunting is zinc deficiency. Through several assemblies, the Ministry of Agriculture, in this instance agricultural research and development agency, is attempting to combat stunting. The Minister of Agriculture's Decree number 168/HK.540/C/01/2019 authorized the release of Inpari IR Nutrizinc in 2019. With an average Zn level of 29.54 ppm, the potential Zn content of In Nutrizinc reached 34.51 ppm [7]. By eating Inpari Nutrizinc rice, the population can overcome iron deficiency and increase nutrition [8].

Inbred irrigated lowland rice (Inpari), which has been released as superior varieties following the Minister of Agriculture's Decree based on their description [6,9], are new superior varieties of special and site-specific rice. The following are yield potential and disease and insect resistance: With a potential yield of 8.42 t/ha of dry milled grain (DMG) and an average yield of 6.3 t/ha, Inpari 32 is resistant to blast, bacterial leaf blight (BLB), and tungro to a moderate extent. With a potential output of 10.58 t/ha DMG, Inpari 42 produced an average yield of 7.11 t/ha DMG and showed considerable resistance to leaf blast, bacterial leaf blight, and brown plantoppers. With a potential yield of 9.5 t/ha, Inpari 45 produced an average of 7.1 t/ha of DMG and exhibited considerable resistance to bacterial leaf blight, brown planthopper, and tungro. With a yield potential of 9.98 t/ha and an average yield of 6.21 t/ha, Inpari Nutrizinc exhibited considerable resistance to brown planthopper biotype 1.2 and minimal susceptibility to biotype 3, resistant to blast, bacterial leaf blight, and tungro to a certain extent. Pamelen has an average yield of 6.73 t/ha and a production potential of 11.91 t/ha. It is resistant to blast and tungro and has moderate resistance to brown planthopper biotype 1, while it is slightly vulnerable to biotypes 2 and 3.

Planting rice with produces functional rice has benefits for plant performance in addition to increasing farmers' revenue because functional rice, such as Pamelen and Inpari Nutrizinc, sells for more money than regular white rice. A decrease in rice productivity is also supported by improper planting practices. A combined harvester can help minimize crop losses, but other inputs in farming—such as overuse of pesticides that make diseases and pests more resilient, excess fertilizer that plants cannot fully absorb, and subpar irrigation systems—also contribute to rising costs. production that is out of proportion to the outcomes obtained. To affect raising crop yields, an integrated technology package must be implemented. However, farmers are not well-versed in the use of integrated rice farming technology packages, which is partly because agricultural instructors in Kebonagung Madiun village have not provided farmers with extensive instruction on this technology.

When the government introduced P2BN, the Research and Development Agency introduced a technology package called integrated crop management (ICM) to boost rice production [10]. The software was then renamed ICM-Jajar Legowo Super after the Jajar Legowo 2:1 super cropping pattern was improved [11]. The Jajar Legowo Super technology component is an integrated cultivation technique for rice fields that receives irrigation. It consists of four parts: (1) utilizing Jajar Legowo 2: 1 planting as the foundation; (2) employing New Superior Varieties (NSV) with high yield potential; (3) providing bio-decomposers before processing; and (4) Plant pests (organisms that damage plants) are controlled with plant-based and inorganic pesticides according to control thresholds, and biofertilizers are used as seed treatment and balanced fertilization based on Soil Testing Equipment (STE) (6) Agricultural implements and equipment, particularly for harvesting (combination harvester) and planting (jajar legowo transplanter).

Based on Jajar Legowo type 2:1, Jajar Legowo super technology is an integrated agriculture method for lowland rice grown under irrigation. Among the technologically integrated components are: 1) New superior varieties (NSV) with high potential yield 2) Biodecomposers applied before tillage 3) biological fertilizers used for balanced fertilization and seed treatment 4) the use of organic and vegetable insecticides to control organisms that harm plants 5) agricultural implements and machinery for harvesting (combine harvester) and planting (jarwo transplanter). In Ref. [2]. If you want to build the Jajarlegowo super technology, however, choosing the location becomes crucial. It includes 1) technically irrigated rice fields 2) Soils with high productivity, high P and K nutrient levels, or high cation exchange capacity 3) Straw is often harvested by immersing it in the field and using a motorized thresher [12].

Measures of the public acceptance of technology include the adoption rate and degree to which technology spreads or diffuses into new areas. The degree to which newly introduced technology is meeting the demands of nearby farmers can be determined by looking at the adoption rate of that technology. If the technology is to be developed on a larger scale and meet the needs of farmers, the acceptance rate suggests that the technological component needs to be improved [13]. It's crucial to socialize farmers through approach approaches for delivering innovations so they will be eager to accept the technology [14]. One hypothesis that aims to explain how new ideas can emerge and be embraced by society is the theory of innovation dissemination.

With the use of components of balanced rice cultivation technology, organoleptic tests of the rice produced, and data on public acceptance of the technology applied from the counseling results, the research is aimed at determining the response to the growth and production of new superior rice varieties specifically and site-specific on Kebonagung village, Madiun, East Java, Indonesia.

2. Materials and methods

The study was carried out from June to September 2021 in the paddy fields of Kebonagung village, Madiun district, East Java, Indonesia. Five different kinds of technology packages were used in a randomized group for the five iterations of the experiment. Approximately 0.3 ha of land is used by each treatment/replication unit. A new, superior variety of SS seed class, a nursery in "dapog," soil cultivation with a tractor, planting with a jarwo transplanter, balanced fertilization, control of plant pesticides and organic pesticides, transmitted irrigation, and harvesting each variety with a combine harvester is all part of the technological component package.

2.1. Materials and tools

Materials used include stationery, fertilizers, insecticides, fungicides, herbicides, rice seeds, and materials for experimental needs. A collection of field auxiliary equipment for trials, implementation tools (two-wheel tractor, jarwo transplanter, combine harvester machine), post-harvest, agronomic observation tools, and data processing tools are among the tools employed.

2.2. Procedure

Previously to the rice being planted, a survey regarding farmer knowledge and reactions to the integrated rice planting technology was conducted, along with a discussion about the planting land layout. The following is how the technical survey was conducted.

2.3. Farmers' knowledge and response survey

A sample of sixty farmers in Kebonagung village participated in the survey, thirty of them were cooperators who were actively involved in activities, and the remaining thirty farmers were non-cooperators who were not involved in this research. Using a purposive sample approach, the sample or survey target was chosen based on target farmers who had fully or partially adopted integrated rice planting technology. Twenty-three farmers from Kebonagung Madiun village and farmers from neighboring villages provided the sixty samples that were selected. To determine the influence of the outcomes of the activities conducted in the research region, a list of questions concerning rice-growing technology was created and distributed to farmers both before and after the activity. To quantify a person's or a group's attitudes, views, and perceptions concerning social phenomena in this case, the cultivation technology survey data is created using a Likert scale.

2.4. Survey data processing

Primary and secondary data sources were used to gather the information. The core data comes from interviews conducted with cooperating farmers, while the secondary data comes from activity-related data obtained from the village office or offices. To ascertain the percentage score of the responses, the data was descriptively analyzed. Following this, scoring criteria and interpretation were completed for additional analysis using path and correlation analysis to ascertain the relationship between the survey items that support technology acceptance. It is also done in advance to categorize the internal and external elements that are most conducive to the adoption of technology. Internal factors are those that originate from within an individual when they create or discover something that subsequently benefits a large number of others, for example. In this instance, perception is influenced by internal characteristics, specifically occupation, age, and education. In contrast, external influences are those that originate from outside of an individual throughout the process of creating or discovering anything. In this instance, perception is influenced by outside variables, specifically knowledge and experience.

2.5. Rice planting uses cultivation technology

2.5.1. Extraction and analysis of soil nutrient status

Before applying balanced fertilizer, soil samples are taken to assess the state of the nutrients. This is the first step in the planting of rice. The soil laboratory of AIAT East Java analyzed soil samples. A poor fertility level was found in the soil based on tests for soil pH, C-organic, N-total, available P2O5, K, Ca, Mg, Fe, and Zn. The C-organic content of the soil was 0.91 % (very low), the N-total was 0.14 % (low), the available P2O5 was 51 % (very high), and the K value was 0.32 cmol(+).kg-1(low), 14.06 cmol(+) of calcium. cmol(+), Mg 5.43 kg-1 (high).Zn 15 ppm (adequate), Fe 8345 ppm (adequate), and kg-1 (high). Fertilizers, particularly N, P, and K, must be added to less fertile soils with somewhat alkaline pH levels to meet nutrient requirements and boost rice yield.

2.5.2. Seeding

The research and development agency's Inpari 32, Inpari 42, and Inpari 45 are new superior varieties that are location-specific, while Nutrizinc and Pamelen are new superior varieties of special rice with SS seed class. These are the new superior varieties that are utilized. The usage of seeds is crucial since one of the seeds is essential to the success of rice cultivation operations [15,16]. To boost plant vigor, the seeds are treated with a biofertilizer before planting using the dapog method. When planting paddy with a rice transplanter, the "dapog" nursery is frequently used [17]. The rice "dapog" technique is grown on trays or plastic sheeting, therefore the nursery medium employs fertile soil mixed with organic fertilizer. "Dapog" can be created on-site with plastic sheets and a planting media that is a 3:1 ratio of soil to manure [2].

2.5.3. *Plantation*

Use the leftover rice straw from the previous harvest as an additional organic fertilizer in the soil, it is smoothed out on the ground and allowed to degrade for about a month before planting. Next, the soil is plowed until it is flat and ready to grow rice. One more component used is tractor cultivation, together with transplanter planting. At the trial site, farmers have traditionally used tractors for cultivation. However, the equipment operator was not yet at the best level to operate because the transplanter planting was limited to the activity itself. When the seeds were 15 DAS (days after sowing), planting took place. Planting with a 2:1 Jarwo Transplanter.

2.5.4. *Plant maintenance*

IAARD guidelines are followed for balanced fertilization. The demo farm activity is located in the Madiun district's Balerejo sub-district, Kebonagung village with NPK Phonska 15:15:15 = 200 kg/ha, urea = 200 kg/ha, and ZA = 100 kg/ha. Three times is the fertilizer administered: once at the age of 7–10 DAP (days after planting); once at the ages of 25–30 DAP; and once at the ages of 40–45 DAP. The technique of fertilizing rice plants by adjusting the spacing between rows by the Jajar Legowo plant application.

By alternating between dry and flooded conditions, the land is irrigated intermittently, which conserves irrigation water and increases the area that can be irrigated. This also helps to reduce the number of organic acids and H_2S gas that can inhibit root development and allows plant roots to grow deeper and lessens the risk of iron poisoning, activates microbial microbes that inhibit, lessen lodging, cut down on unproductive tillers (those that don't produce panicles or grain), uniformize grain ripening and expedite harvest time, facilitate fertilizer application into the soil (tilling layer), lessen the spread of brown planthoppers and stem borers, and lessen damage caused by rat pests to rice plants [18]. To stop pest resistance and disease in rice, plant pests (plant-disturbing organisms) are used along with plant-based and inorganic pesticides based on control levels. The process of irrigation involves emptying the water, allowing it to stand still for four days, and then drying it for three days.

2.5.5. *Harvesting*

Harvesting using a Combine Harvester involves combining the tasks of chopping, storing, threshing, and cleaning in one go [19]. Observed parameters comprised: Development of biology and plant yields Plant height for both generative and vegetative growth, quantity of both productive and non-productive tillers, and area of flag leaves. Production: Production, production components

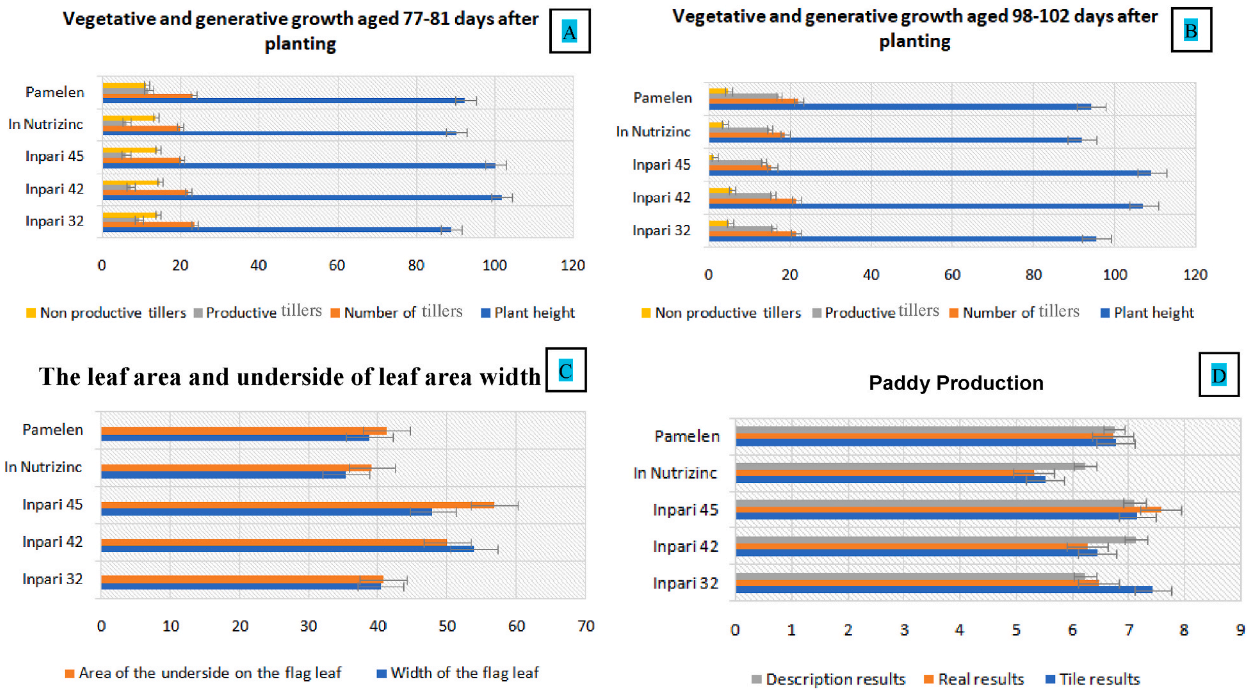

Fig. 1. Vegetative and generative growth on 77–81 DAP (A), vegetative and generative growth on 98–102 DAP (B), Leaf flag area and underside of leaf flag area width (C), production components of paddy (D).

(length, width, number of grains in a panicle, number of full grains in a panicle, and number of empty grains in a panicle)

2.6. Analysis of agronomic and production data

Data on agronomy and productivity were examined using analysis of variance, and DMRT testing was conducted at a 5 % level.

3. Results

3.1. The influence of cultivation methods on growth, production, rice quality, and consumer acceptance

3.1.1. Vegetative and generative growth

Plant height, the number of tillers, the number of productive tillers, and the number of non-productive tillers are all factors in biological development and plant yields. The plant heights of Inpari 42 and Inpari 45 at 77–81 DAS (Fig. 1) were not different from those of Inpari 32, Inpari Nutrizinc, and Pamelen, although they were. The tallest plants were found in Inpari 42 and 45 (100.22–101.90 cm), while the smallest plants were found in Inpari 32 (88.97 cm). Inpari 32 had the greatest number of tillers (23.64), which was the same as Inpari 42 and Pamelen. Inpari Nutrizinc had the fewest tillers (19.92 tillers), and it was identical to Inpari 42 and Inpari 45. In contrast to previous treatments, Pamelen had the greatest number of productive tillers—11.88—and the lowest number of non-productive tillers—11,37. There are still variations in growth, particularly in plant height and the number of fruitful tillers, as the age of 62–66 marks the beginning of the generative period.

Inpari 42 and Inpari 45 plant heights were not different from Inpari 32, Inpari Nutrizinc, and Pamelen, but they were at various ages (98–102 DAS) according to observations (Fig. 1). The plant heights of Inpari 42 and 45 ranged from 107.11 to 109.16 cm, whereas Inpari Nutrizinc had the lowest plant height of 91.99 cm. In addition to giving a considerable number of tillers (21.47–22.07 tillers), Inpari 32, Inpari 42, and Pamelen did not differ in the number of tillers they provided from Inpari 45 and Inpari Nutrizinc. The results also included the number of non-productive tillers. There was no difference in the number of productive tillers for Pamelen, Inpari 32, and Inpari 42, but there was a difference for Inpari 45 and Inpari Nutrizinc.

3.1.2. Flag leaves

There were variations in all treatments according to the statistical analysis of the flag leaf area and the flag leaf's underleaf area. Fig. 1 shows the area of the flag leaf's underside as well as its average width. While Inpari Nutrizinc has the narrowest area (35.38 cm2) and is similar to Inpari 32 and Pamelen, Inpari 42 has the widest leaf area (53.88 cm2) and is distinct from Inpari 32, Inpari Nutrizinc, and Pamelen (Fig. 1). Regarding the flag's broadest leaf area (56.86 cm2), Inpari 45 is similar to Inpari 42 but distinct from Inpari 32, Inpari Nutrizinc, and Pamelen. Because Inpari 45 and Inpari 42 have the widest flag leaf areas and bases relative to the other varieties, their yields will be larger. Across all treatments, the flag leaf's average state was upright and inclined at a 10° angle.

3.1.3. Panicles and grain

Differences were seen in the panicle and grain components' length, width, number of grains within, number of full grains within, and number of empty grains within, as determined by statistical analysis. In Fig. 1, the average length, width, number of grains, number of full grains, and number of empty grains per panicle are displayed.

3.1.4. Production potential

Based on actual and theoretical findings, the potential for rice production in the hamlet of Kebonagung village, Balerejo sub-district, is computed from the outcomes of demo farm operations. The true results come from harvests using the combine harvester; the outcomes of tiling the plants are 5 m long and consist of three plant alleyways. Fig. 1 shows the production of paddy for all tile and real treatments. Based on tiles, Inpari 32 and 45 had the highest output yields, whereas Inpari Nutrizinc produced the least, at 5.5 tons/ha. The discrepancy between the simulation findings and the actual Combine Harvester outcomes is negligible, ranging from 0.05 to 0.96 tons.

Real and tiled yields are the basis for calculating production yield potential. The actual results are acquired by harvesting with a Combine Harvester machine; the results of tiling plants the size of three plant aisles and a length of 5 m are equal to 1.4 m by 5 m (Fig. 1). The average yield based on variety descriptions was approximately 7.1 tonnes/ha, however, production of Inpari 45 from actual yields harvested using a combine harvester reached 7.56 tonnes/ha, with tile yields of 7.14 tonnes/ha. In the case of Pamelen, the tile yield is 6.75 tons/ha, the real yield is 6.7 tons/ha collected with a combine harvester, and the average yield according to the variety description is 6.73 tons/ha. When compared to the average yield based on the variety description, the production of Inpari 45 (a new superior rice variety for specific regions) and Pamelen (a new superior variety for special rice) differs by only a small amount or about 0.5 % for Inpari 45 and 0.4 % for Pamelen. Pamelen production was higher than In Nutrizinc, whereas Inpari 45 production was higher than Inpari 32 and Inpari 42. With an average production of about 6 tons/ha, Inpari 32 is an existing variable in the Kebonagung area. By applying innovation, the yield of tiled harvest increased to 7.42 tons/ha, or 23 %, while the real yield increased to 6.46 tons/ha, or 7.7 %.

3.1.5. Rice quality

Differences have been found in the organoleptic rice statistical study results for color, aroma, texture, taste, and acceptability. Additionally, there are variations in the rice's brightness, redness, and yellowness. Fig. 2 displays the average rice organoleptic test.

There were 40 participants on the panel, and the organoleptic test was based on the scoring outcomes. While Inpari 32, Inpari 42, and Inpari 45 did not differ much from Inpari Nutrizinc and Pamelen, they did differ in terms of color, scent, texture, and taste. Although Inpari Nutrizinc and Pamelen are not the same, they do have different textures. In comparison to Inpari Nutrizinc and Pamelen, the panelists favored Inpari 32, Inpari 42, and Inpari 45 rice, with no discernible variation in acceptability among them. Pamelen's genetic makeup accounts for a large portion of her red color.

"tungro": Tungro is one of the most damaging and destructive diseases of rice in South and Southeast Asia. "dapog": The system of seeding rice seeds using a special nursery tray

"Jarwo"/"Jajar Legowo": rice cropping system with a certain spacing using a transplanter

"Inpari": superior lowland rice variety

"Pamelen" brown rice variety, as functional rice

"Inpari NutriZinc": a superior rice variety that has a high zinc content to overcome growth and development disorders in children due to long-term malnutrition

3.1.6. Community acceptance: adoption and diffusion of innovation

Nine technologies are included in the jajar legowo technology package that is used: using a combine harvester for harvesting, intermittent irrigation, integrated control of organisms that disturb plants, fertilization based on recommendations, planting jajar legowo using a transplanter, using a tractor for land management, using decomposers, dapog nurseries, and using new, superior varieties. Three of the nine technologies that are utilized are: using tractors to process land, using new, superior kinds, and land processing. These three technologies have relatively high profit values. When it comes to technological application simplicity, three technologies stand out: tractor-based land cultivation, intermittent irrigation, and fertilizing according to recommendations.

Three technologies—land processing with a tractor, intermittent irrigation, and harvesting with a combined harvester—are the most appropriate to be implemented, according to the technology's compatibility with farmers' demands and the current state of their land. The most profitable, simple, and appropriate technology for farmers to implement are the nine now in use, including tractors and intermittent irrigation. Many of the farmers who responded to the survey and the farmers in the surrounding area of the Kebonagung village employ this existing technology. The presence of an integrated irrigation system from drilled wells in the surrounding areas

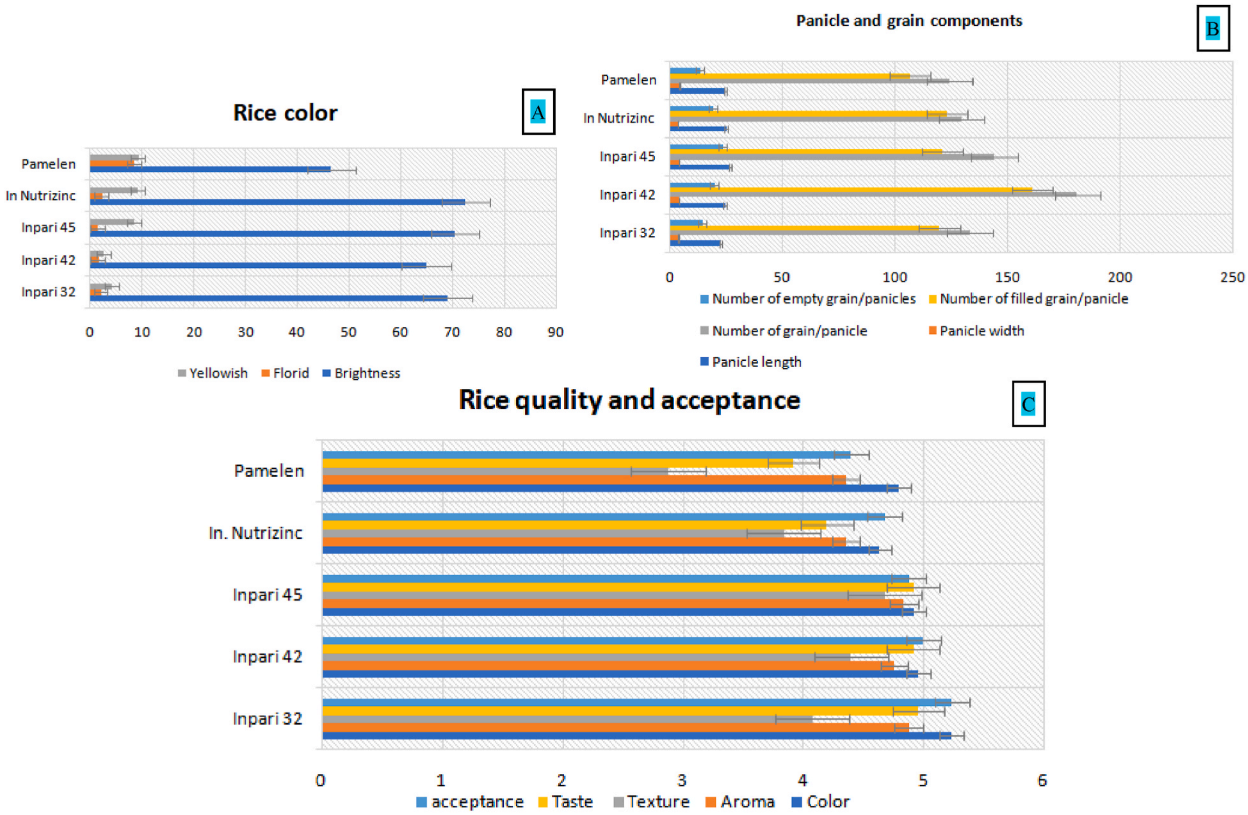

Fig. 2. Rice component quality and its acceptance, (A) rice color, (B) panicle and grain components, (C) rice quality and acceptance. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

supports the deployment of an intermittent irrigation system.

Farmers tend to be very interested in innovation related to the technology offered (79.38 %), and they are also highly interested in putting this technology into practice (75.58 %). On the other hand, farmers' use of technology is moderate (50.20 %), and their managerial skills are also moderate (65.62 %). This is consistent with lawmakers' adequate support for policies (37.82 %) and their support for equipment that facilitates technological innovation, which was made possible with the use of a jarwo transplanter planting tool. Some farmers bemoan the operational costs of raising seedlings, planting, and harvesting, while other supporting technology components—like hiring labor for Jajar Legowo transplanter machine operators, providing easy access to seed availability (without seed cultivators), fertilizers, and medications—remain unavailable.

Using primary data from survey research methods, a correlation test is used to determine the relationship between internal and external factors and the intensity of adoption by farmers. Specifically, the value of r count $\geq$ r table or Sig hit $\leq$ Sig prob ($0.000 < 0.05$) is compared. Purposive location determination was used, specifically in the village of Kebonagung, Balerejo District, and Madiun Regency, and simple random sampling was used for the research sample. The lottery is used as the taking method. With a sample size of $n > 30$ and a total of 50 respondents, the observed values will converge to the normal distribution [20].

Internal factors are those that originate from within the person; from there, the person takes in, processes, and selects all external inputs, deciding which ones to accept and which to reject. External influences are those that originate from without the person and take the form of stimuli intended to mold and alter attitudes [21]. Table 1 presents internal parameters associated with farmers' adoption intensity.

The degree to which the Legowo Jajar technology package is being adopted has little to do with the farmer's age, level of formal education, experience, or duration of farming. It will be challenging to accept new technology, even if the bulk of farmers fall into the productive age group that can and does embrace it since they have become ingrained in farming operations due to their experience and habits [22]. Anybody, regardless of age, can use the Jajar Legowo technology. Farmers' decisions to accept innovations will not be influenced by their level of education, whether it is high or low. Since farmers do not need to have a high degree of education to apply technology in farming, there is no substantial correlation between education level and level of technology adoption [23]. where farmers with lower levels of education may not always possess greater skills and knowledge than farmers with higher levels of education.

The amount of time farmers have been farming also has no bearing on how quickly technology is adopted since they place greater trust in their years of successful agricultural business management even in the absence of jajar legowo technology. The findings of the analysis of external factors indicate that, as shown in Table 1, the link between variables and the degree of jajar legowo adoption in the Kebonagung village is in the medium and high categories.

Results from the selling of rice business indicate a correlation between the level of adoption of the Jajar Legowo technology package and market access. The economic benefits of adopting combined harvester technology over hand harvesting are thought to stem from the ease with which harvests may be sold. Thus, in comparison to employing a combined harvester, labor wages for harvesting are more costly and challenging to obtain. Furthermore, this technology is already in place and frequently utilized by nearby farmers, making it easier for farmers to embrace and use.

In general, the typical cooperating farmers who used the technique A total of 22 cooperator farmers, or 100 %, embraced PPO control, transmittant irrigation, tillage using tractors and planting transplanters, "dapog" nursery technique, and combined harvesting. Farmers typically use this technology, which is already in use. Of the cooperating farmers, 80 % (17 persons) used NSV, whereas only 27 % (6 people) used fertilization. Farmers used to utilize subsidized fertilizers, but the technology package employed non-subsidized fertilizers, which were more expensive and difficult for farmers to access. As a result, less fertilization was used. Furthermore, new technology will offer comparatively significant advantages over outdated technology, accelerating the pace at which innovations are adopted [24].

Farmers are being introduced to seven new technologies. On average, farmers use between five and seven different technologies. Farmers can embrace all of these components at a 100 % adoption rate; if they adopt six technologies, that rate is 85.71 %; if they adopt five technologies, that rate is 71.43 %. With an average adoption rate of 87.66 % per cooperating farmer, Table 2 indicates that this adoption rate is exceptionally high. This is how the adoption rate is categorized: < The adoption rate classifications are as follows: 20 % is classified as very low adoption rate, 20.01–40.00 % as low adoption rate, 40.01–60.00 % as medium adoption rate, 60.01–80,00 % as high adoption rate, and 80.01–100 % as very high adoption rate [25].

The path coefficient shows the outcomes of the analysis of the structural model by examining the importance of the influence between the constructs. The bootstrapping process (resampling approach) yields the *t*-test value (critical ratio), which can be used to determine the importance of the route coefficient. The *t*-test results for the inner and outer models are shown below. The bootstrap calculation's *t*-test yields the *t*-test result. Next, the *t*-test results in Fig. 3 and the t-table values will be contrasted.

Table 1
The relationship between internal factors and the adoption intensity of the jarwo technology package.

Internal Factor	Sig.(2 tailed)	Correlation	Annotation
Farmer's age	0,803	0,061	Unconnected
Formal education	0,101	−0,388	Unconnected
Knowledge	0,368	0,219	Unconnected
Farming period	0,697	0,096	Unconnected

Source: Primary data, 2021

Table 2
Relationship between external factors and jajar legowo adoption intensity.

External Factor	Sig.(2 tailed)	Correlation	Annotation	Relationship Level
Market access	0,023	0,517*	Connected	Moderate
Support of Farmers Groups	0,125	0,365	Unconnected	–
Information Support	0,486	0,170	Unconnected	–
Relative advantage	0,046	0,463*	Connected	Moderate
Convenience	0,005	0,620**	Connected	High
Compatibility	0,002	0,674**	Connected	High
Managerial capabilities	0,870	−0,040	Unconnected	–
Interest in innovation	0,036	0,482*	Connected	Moderate
Interest to implement	0,253	0,276	Unconnected	–

Source: Primary data, 2021

A few of the farmers' internal and exterior traits both directly and indirectly impact how much of an impact the Jajar Legowo technology package has (Fig. 2). Knowledge, market access, support for farmer groups, and information support are internal attributes that directly impact interest in innovation. Whereas the following external factors—relative advantage, convenience, appropriateness, and managerial ability—directly and strongly influence interest in innovation. Up to 84.7 % of interest in innovation is influenced by these internal and external factors, with the remaining 15.3 % coming from contributions from other, excluded characters. Age, length of agricultural experience, and formal education do not significantly impact one's interest in innovation.

External factors (relative advantage, convenience, suitability, and managerial skill) have a direct and significant influence on interest in implementing technology up to 38.3 %, whereas other factors influence 61.7 % of the respondents. Age, education level, number of years of farming, and internal characteristics (knowledge, market access, support from farmer associations, and information assistance) are unrelated to farmers' desire to use technology.

The degree of technology adoption is not significantly impacted directly by a number of the evaluated criteria, such as age, education level, length of agricultural experience, and other internal traits like inventiveness and technology application interest. Relative advantage, convenience, appropriateness, and management skills are the external characteristics that have the biggest direct impact on technology adoption (72.9 %). The diffusion of technology has reached several neighboring districts (Fig. 4).

Fig. 4 shows how the four sub-districts of Madiun, Wonoasri, Gemarang, and Saradan dispersed the Jajar Legowo technology package in Kebonagung village, Balerejo sub-district. Information exchanged between farmers in different sub-districts and between farmers and sub-district officials forms the basis of information on the diffusion flow. A few of the technologies that are being mimicked are "dapog" nurseries, sporadic irrigation, tractor-driven tillage, combine harvesters for harvesting, and Jarwo transplanters for planting.

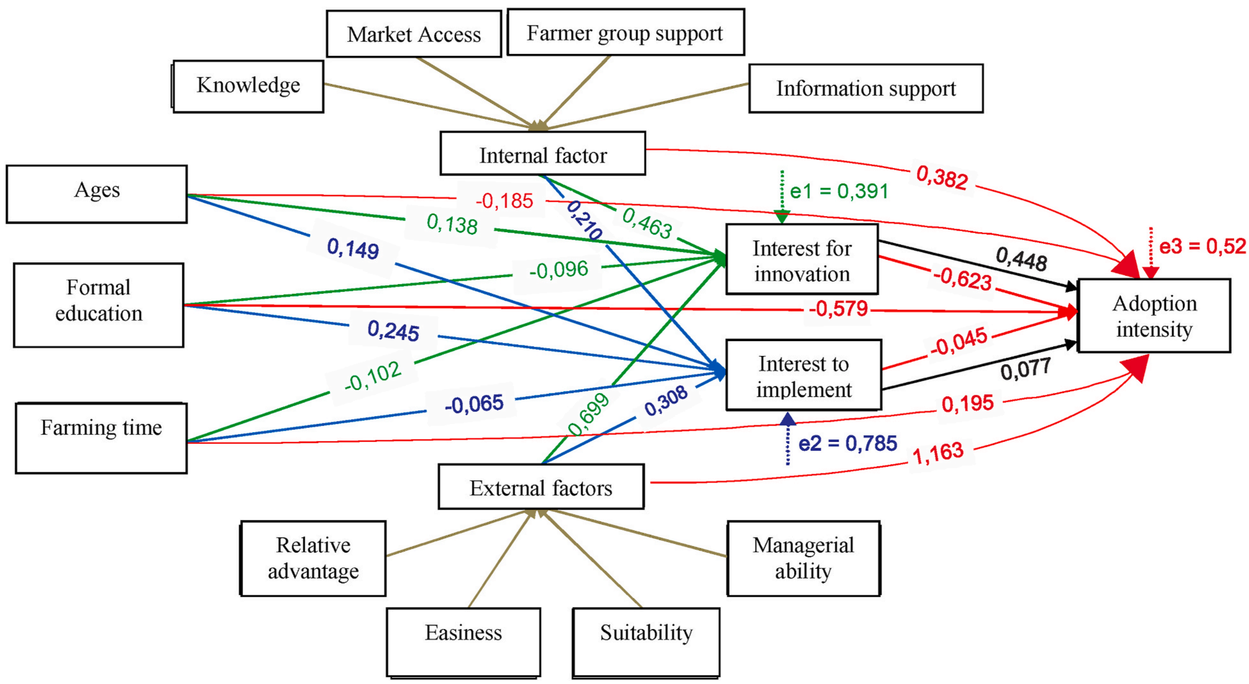

Fig. 3. Path diagram of direct and indirect effects of factors affecting adoption intensity using the path coefficient method.

Fig. 4. Map of the technology diffusion of several sub-districts in the Indonesian Madiun district.

4. Discussion

The biological development of plants at 77–81 and 98–102 days after seeding Pamelen had the most productive tillers, although Inpari 42 and 45 demonstrated the best plant performance. All treatments were harvested between 109 and 111 DAS. The widest flag leaf below, together with the Inpari 42 and 45 flag leaves. Inpari 42 yielded the greatest quantity of both empty and full grain/panicles in comparison to other treatments. For Inpari 32 tiles, the maximum production potential is 7.42 tons/ha, but for Inpari 45 tiles, it is 7.14 tons/ha. Inpari 45 had the highest real yield at 7.56 tons/ha, while Pamelen came in second at 6.7 tons/ha. Leaves known as flag leaves are crucial to the production of rice. Following the flowering phase, the rice grains start to fill with the carbohydrates made in the flag leaf during the grain-filling phase. In this instance, a larger flag leaf area will result in a higher carbohydrate contribution and higher production. In addition, the findings will be impacted if the flag leaf is not green and is sloping. This is confirmed by the fact that the flag leaf is upright.

The panicles of Inpari 45 are the longest, whereas those of Inpari 32 are the smallest. It produces findings that are wider than the others for Pamelen's panicle width. While the number of empty grains per panicle was highest in Inpari 45, the grain components of Inpari 42 produced the maximum number of grains per panicle and full grain per panicle and were distinct from other treatments. The production of panicles is the most significant process during the generative phase. In addition to plant genotype factors, which have a wide range of variability, the development of rice panicles is also influenced by the interplay between genotype and environment [26]. Environmental elements that impact plant development during the flowering period include drought, high temperatures, and nutritional shortages [27]. Inpari 42 generated the largest grain due to its genotype producing the widest flag leaf area (Fig. 1). This confirms other studies' findings that yield is positively impacted by the flag leaf's length, width, and area.

Panelist approval favors Inpari 32, Inpari 42, and Inpari 45 above InpariNutrizinc and Pamelen in terms of color, aroma, taste, and texture based on the organoleptic results of rice. Pamelen's redness is extremely red, Inpari 45 is yellowish in hue, and Inpari 32, 45, and InpariNutrizinc are all brighter when it comes to rice brightness. According to the variety description results, the plant height for Inpari 45 can reach 120 cm, whereas Inpari 42 can reach 93 cm [11] and Inpari 42 can reach 107 cm in the Madiun site. The environment is to blame for this. The environment has a big impact on how plants develop. Since the rice plant had reached the reproductive period after 80 days, more tillers were releasing panicles, resulting in an increase in the number of productive tillers from 77

DAS to 102 DAS [27].

The interest in innovation is approximately 79.83 %, and the desire to put it into practice is 75.58 %, which places the community's embrace of technology in the high category. For every cooperating farmer, the rate of technology adoption is 87.66 %. Technology packages swiftly spread to neighboring communities, particularly the subdistricts that were closest to the site of the action. Because farmer group meetings hosted by the BPP (Agricultural Extension Center) in the sub-district are only held 1–2 times a month and cover a variety of topics (not just the rice planting system with Jarwo), farmers feel that the support and information provided are insufficient and not yet intense. As a result, farmers are reluctant to adopt the jajar legowo technology. The degree of innovation adoption is significantly impacted by the availability of information. The adoption of innovations is positively correlated with farmers' access to information [13].

Since information is communicated using applications utilizing various technology stages—particularly jajar legowo—extension actions foster genuine relationships. Farmers will be more likely to use the jajar legowo technology if they participate in counseling. In actuality, nevertheless, knowledge concerning jajar legowo technology is not thoroughly explained and focuses solely on theory rather than application. The quality of farmers will be improved through non-formal education in the form of agricultural extension training and activities. As a result, the faster farmers adopt new technologies, the more active they are in agricultural extension [24].

The degree to which newly introduced technology meets the demands of nearby farmers can be determined by looking at the adoption rate of that technology. To create technology on a larger scale and by farmer demands, the acceptance rate suggests that the technology component needs to be improved [13,28]. Table 2 shows that several external factors impact farmers' adoption of technology, but there is no correlation between the intensity of adoption with management aptitude or desire to use technology. This demonstrates how challenging it is for managers to provide the necessary resources to enable the implementation of Jarwo technology, including money, manpower, planting and seedling schedules, and seed, fertilizer, and pesticide access [29]. Moreover, there is no correlation between enthusiasm for implementing technology and amenities, such as administrative skills, which farmers often struggle to provide.

However, farmers are aware of the relative benefits, ease of use, and compatibility with the current circumstances of the Jajar Legowo technology package. Relative advantage and technological suitability have a modest association, but ease and suitability have a strong link. Local farmers' accounts suggest that the Jajar Legowo technology bundle can reduce the amount of labor and planting time required for agricultural businesses. Furthermore, a variety of NSVs are employed, particularly those that are particular and well suited to the growing environment, which generates numerous financial gains for farmers.

Conditions on the farm reveal that enthusiasm for innovation has a moderate link with the degree of technology adoption. For instance, farmers find "dapog" technology appealing since it reduces space, time, and implementation hassles when compared to nurseries, which are typically managed by farmers. The type of innovation and the degree of Legowo Jajar technology adoption reveal a true relationship, which includes the degree of profit, the degree of complexity, the degree of suitability, the opportunity to try, and the opportunity to observe [30]. Farmers will adopt an invention if it can be used technically, is profitable commercially, and can be explained sociologically.

5. Conclusions

A major function of Madiun is the creation of special and site-specific HSV rice. Because of its high nutritional content, HSV for specific rice is very advantageous from a health perspective; however, HSV for specific rice needs to be introduced as a substitute variety. Rice agriculture is particularly essential because the Madiun district has a large potential area for paddy fields—roughly 21,587 ha—with a productivity of 6.89 tons of rice per hectare. In connection with this, it is anticipated that the adoption of technology in the rice-growing industry will boost rice farmers' earnings. Rice farmers in particular can learn a lot from the implementation of new developments in HSV farming technology for rice. HSV rice, machine-assisted cultivation (tillage with a tractor, planting with a Jarwo transplanter, harvesting with a combine harvester), balanced fertilization, and the use of organic and botanical pesticides to control organisms that disturb plants are some of the components incorporated into these innovations.

To ensure that the technology is swiftly accepted, the deployment of these technical advancements may positively affect the implementation outcomes and farmer behavior. When it comes to the classification of individual farmer acceptance rates for the application of technological innovation, this has shown to be extremely high. Under these circumstances, technology spread fast to other areas or other districts. Information from neighborhood farmers and field officers forms the foundation of the diffusion process. To sustain technical innovation and foster its ongoing development, cooperation from relevant authorities and the local government is anticipated.

CRediT authorship contribution statement

Titiek Purbiati: Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Listy Anggraeni:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sugiono Sugiono:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. **Thohir Zubaidi:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing – original draft. **Sudarmadi Purnama:** Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing – original draft. **Catur Hermanto:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft. **Amik Krismawati:** Data curation, Formal analysis, Validation, Writing – original draft, Writing – review & editing. **Zainal Arifin:** Data curation, Formal analysis, Software, Validation, Visualization, Writing – original draft. **Sri Satya Antarlina:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. **Juliana Carolina Kilmanun:** Data curation, Formal analysis, Investigation, Software, Visualization, Writing – original draft. **Ita Yustina:** Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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