Study on Application of TSS (True Shallot Seed) Shallot Technology in Gorontalo

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Abstract. The aims of the study were: 1) to determine the seeding performance, growth and yield performance of shallot cultivation from TSS (True Shallot Seed), 2) to determine farmers' perceptions of TSS shallot technology, and 3) to analyze the financial of TSS shallot farming in Gorontalo. This TSS shallot applied study was conducted in Gorontalo in 2019. To find out the best seeding technique using a Randomized Block Design (RBD) method with 6 treatments and 10 replications. Farmers' perceptions were analyzed using percentage techniques using a Likert scale based on 30 respondents. Farm financial was analyzed descriptively by calculating revenue, cost and R/C ratio. The results showed that the best TSS shallot seeding was obtained in raised beds with paranetal cover with a growth percentage >90 percent. The growth percentage of TSS after transplanting reached >80 percent with a productivity of 4.9 tonnes/ha. The average farmer's perception of TSS shallot technology showed that the TSS shallot cultivation technology produces tubers of excellent quality, saves seed costs, and farmers are interested in implementing it again. The results of farming financial analysis showed that the TSS shallot farming had an R/C ratio of more than 1 which means it is efficient to implement.

1 Introduction

Shallots are one of the strategic horticultural commodities that have high economic value in Indonesia. Shallots are widely consumed by people as the main spice in various dishes. According to [1] and [2] Shallots are widely used as cooking spices that contain nutrients that are useful for the health of the human body. Shallots are also used as industrial raw materials with various derivative products such as fried onions, flour, oil, dry slices, wet slices, pasta and various other processed shallot products. The shallot commodity also has an influence on the national economy, because it can affect inflation due to an increase in the price of shallots in the market [3, 4].

The great benefits of this shallot commodity have caused an increase in demand which continues to increase from year to year so that it must be supported by an adequate supply of production. National shallot production in 2018 reached 1,503 million tons, which tends to increase compared to 2017 production, which reached 1,470 million tons [5]. Even though Indonesia is capable of producing its own shallots, until now Indonesia is still a net importer of shallots [6]. The main problem faced by farmers in efforts to increase shallot

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production is the limited quality of shallot seeds during the planting season, both in terms of quantity and price [4]. Farmers have an interest in cultivating shallots but are constrained by the very high price of seeds.

In the development of shallots, farmers in Indonesia use more tuber seeds as planting material, because they are easier to apply and harvest faster. However, the use of tuber seeds as planting material has several drawbacks, including the very high cost of seeds, because the need for seed from shallot tuber reaches 1.3-2.6 tons/ha [7, 8]. If the average price of tuber seeds is IDR 40,000, - / kg then the cost of seeds can reach more than IDR 50 million per ha. [9] stated that the cost of seeds can reach 40 percent of production costs. Tuber seeds also tend to be resistant to storage, expensive transportation costs, and often have tuber-borne diseases [10]. According to [11], the use of tubers of the same variety from generation to generation also causes little chance of improving the nature/quality so that the competitiveness of Indonesian shallots tends to decline.

In addition to using tuber seeds, planting materials for shallot cultivation, as an alternative, can also use True Shallot Seed (TSS) seeds [12]. The use of TSS seeds as planting material has several advantages when compared to tuber seeds, including being more efficient in terms of seed costs, seed needs ranging from 3-7.5 kg per ha compared to tubers around 1-1.5 t / ha, free of viruses and seed borne diseases, produce healthier plants, and higher yields than seed tubers .

The results of previous research related to the application of TSS shallot showed that the yield performance was influenced by various factors, including the agroecosystem, socio-economic, and cultural conditions of local farmers. [2] revealed that the productivity of TSS shallots in Central Sulawesi, Indonesia reached 14.9 tonnes/ha with an R/C ratio of 3.15. [13] mentioned that TSS shallots can be planted on dry land in Malacca District, NTT with productivity reaching 5-8.5 tonnes/ha. [3] and [14] revealed that from the farming analysis, TSS technology is feasible to be developed because it can provide greater benefits for farming compared to using shallot seeds from tubers. These advantages enable farmers to switch from cultivating shallot bulbs to TSS shallots and produce disease-free shallots, reducing production costs by half [15]. Furthermore, [16] revealed that the application of TSS shallot technology can be an alternative in increasing the competitiveness of Indonesian shallots.

The implementation of TSS shallots at the farmer level has been carried out since the 1990s, but currently the application of TSS shallot cultivation by farmers is still limited in Indonesia, including in Gorontalo Province. For this reason, an applied study of TSS shallot technology was conducted to obtain information related to the efficiency of TSS shallot farming in Gorontalo. The application study is an activity of testing packages/technology components on farmer's land or at the Agricultural Extension Center as a vehicle to prove and convince the package/technology to suit the specific needs at the study location, as well as a vehicle for joint learning for researchers, agricultural extension agents, and farmers [17]. From the results of this applied study, it is hoped that agricultural extension agents and farmers are willing and able to apply technology.

The aims of the study were: 1) to determine the seeding performance, growth and yield performance of TSS (True Shallot Seed) shallot technology, 2) to determine farmers' perceptions of TSS shallot technology, and 3) to analyze the financial of TSS shallot farming in Gorontalo.

2 Materials and methods

The application study of True Shallot Seed (TSS) technology was conducted on cooperator farmer lands in Ilomangga Village, Tabongo District, Gorontalo Regency, Gorontalo Province, as a vehicle for shared learning for researchers, agricultural extension workers and farmers. The study was conducted from July to November 2019. The method of implementing this applied study was carried out with a participatory approach involving farmer cooperators, researchers, and extension workers in technology assistance, by comparing the introduction of TSS shallot technology with existing technology commonly used by farmers.

This application study tested TSS shallot cultivation from seeding to harvest. The materials used were the Trisula variety TSS shallot seeds, which came from the Vegetable Research Institute (Balitsa), the Indonesian Agency of Agricultural Research and Development (IAARD), fine soil, cocopit (fine coconut coir), granular organic fertilizer, wood sawdust, paranet, seedling box, foliar fertilizers, inorganic fertilizers, and drugs (insecticides/herbicides). For the seeding process, an assessment was carried out on the effect of the seeding media on the growth of TSS shallot seeds. Seedlings are carried out in nursery houses using seedling boxes and directly on raised beds. The technical assessment of the seeding used a randomized block design (RBD) with 6 treatments and 10 replications. The technical treatment of TSS shallot seedings at the assessment location consists of:

P1 = 100 percent soil + grooves cover using soil, in the seedling box
P2 = 100 percent soil + grooves cover using cocopit (fine coconut husk), in the seedling box
P3 = 100 percent soil + grooves cover using organic fertilizer granules, in the seedling box
P4 = 100 percent soil + grooves cover using wet sawdust, in the seedling box
P5 = bed land + granule organic fertilizer + grooves cover using cocopit + paranet cover, in raised beds
P6 = bed land + granule organic fertilizer + cocopit grooves cover using cocopit (without paranet cover), in raised beds

TSS shallot seedings in the screen house using seedling boxes measuring 30 cm x 50 cm x 5 cm. The nursery house uses a UV plastic roof and black paranet walls. Seeding on raised beds measuring 1 mx 20 m, and one plot measuring 1 m x 2 m. The seeding medias were made of grooves with a distance between the grooves of ± 5 cm and the depth of the grooves is ± 1 cm. Meanwhile, the seeding in raised beds is made with grooves with a distance of ± 10 cm with a depth of ± 1 cm. Before scattering TSS shallot seeds in the grooves that have been made, soaked for ± 3 hours and then drained. After that, the seeds were treated with insecticide and ZPT active ingredient Imidacloprid 350 g/l. TSS shallot seeds were then scattered evenly in grooves. After the seeds were scattered, the grooves were closed using the media according to the treatment. On raised beds, the nursery was closed using a black paranet for 4 days. Watering was done regularly using a handsprayer to keep the nursery soil moist. Fertilization was given 6 times during the seeding using foliar fertilizer at a dose of 30 ml per liter of water. The TSS shallot seeding time was for 40 days, and then transplanting it to the planting area.

The planting area of shallots for this study was 0.75 ha, consisting of TSS shallots with an area of 0.25 ha, and shallots planting from tubers of 0.5 ha as a comparison. The shallot varieties from the tuber as a comparison used the Bauji shallot varieties. The spacing of TSS shallots in this study is 20 cm x 20 cm with 2-3 seeds per planting hole. Planting shallots from tubers also use the same spacing of 20 cm x 20 cm, at the same time as the TSS shallot transplanting process. Watering the TSS shallot plants was carried out intensively at 1 week after planting in the critical phase after transplanting. Fertilization uses inorganic NPK fertilizers (15-15-15) at a dose of 850 kg / ha, done twice, where the first fertilization was at the age of 14 days after planting at a dose of 450 kg / ha and the second fertilization at the age of 30-40 days after planting at a dose of 400 kg / ha.

Observation variables in the seeding phase include: percentage of growth, plant height (TSS seed height), and number of leaves taken at 14 days after seeding (DAS), 25 DAS and when the seeds are ready for transplanting (40 DAS). Observation variables in the phase after transplanting to harvest were percentage of growth, plant height, number of leaves, number of tillers, number of tubers, tuber diameter, tuber weight, tuber weight per clump, productivity. The number of samples was 10 plants for each experimental plot.

Data on farmers' perceptions of TSS shallot technology were collected through structured questionnaires (10 questions) that had been prepared in advance and interviews with respondent farmers. The number of respondent farmers is 30 people who are cooperator farmers and are directly involved in applied study activities both in the implementation of the demonstration plot and technical guidance on TSS shallot technology in the field.

For the production analysis, the harvest data that had been collected were tabulated and analyzed descriptively. Observation data in the nursery phase including growth percentage, TSS seed height, and number of leaves were analyzed and further tested with the Duncan Multiple Range Test (DMRT) at a 5 percent confidence interval. While the data in the phase after transplanting until harvesting included plant height, number of tillers, number of leaves, number of tubers, tuber diameter, number of tubers per hill and productivity were not further tested.

To determine farmer perceptions, analyzed using a Likert scale basis. The scales used are: SA = Strongly Agree, A = Agree, D = Doubt, DA = Disagree, and SDA = Strongly Disagree. The data that has been collected by means of a questionnaire, is tabulated using the percentage method for each given statement, and is calculated using the following formula:

$$\textit{Percentage Value} = (n_i : \sum N_j) \times 100 \quad (1)$$

Where :

n_i = the number of respondents who stated (people) in column i (i=1,2,3,…,5)

$\sum N_j$ = number of respondents (people) on line j (j=1,2,3,…10)

For farm financial analysis was done using descriptive method, the data obtained was analyzed by tabulation which includes the structure of costs, revenues, and farm profits. The results of the analysis of revenue and costs can also show the benefits of a farm by calculating the R/C ratio. [18] stated that to calculate R/C Rasio using the total cost. Analysis of the balance of revenue and costs (R/C ratio) was used to see the benefits of farming from the amount of revenue received by farmers for every 1 IDR that has been spent for their farming. Farming is said to be efficient if the R/C ratio is greater than one. The greater the R/C ratio, the more efficient the farm is.

3 Results and discussion

3.1 Growth performance of TSS shallot seeding

The results of variance analysis showed that the treatment of seeding media had a significant effect on the 5 percent level of growth percentage, TSS seed height and number of leaves. The analysis results of the effect of seeding media treatment on the growth percentage, seed height and number of leaves of TSS shallot seeding in Ilomangga Village, Tabongo District, Gorontalo Regency are presented in table 1.

From table 1 it can be seen that the highest growth percentage since the age of 14 days after seeding (DAS), 25 DAS, and the age of the seeds ready for transplanting (40 DAS), was achieved by seeding on raised beds with seeding media: soil, granule organic fertilizer, cover seed grooves using cocopit and using paranet hood (P5). This seeding media was the best media mixture for TSS shallot seedings based on the results of applied studies at the research location with a growth percentage was 98.20 percent at the age of 14 DAS, 96.60 percent at the age of 25 DAS and reaching 93.50 percent at the age of seeds ready for transplanting (40 DAS). The second highest growth percentage was achieved by TSS seeding media in seedling boxes (P2) with media: 100 percent soil and cover of grooves using cocopit (crushed/mashed coconut husk), with the percentage of seed growth at 14 DAS reaching 98.60 percent, age 25 DAS reached 94.70 percent and at the age of 40 DAS reached 89.50 percent.

Table 1. Effect of seeding media on the growth percentage, seed height, and number of leaves of TSS shallot seeding in Ilomangga Village, Tabongo District, Gorontalo Regency in 2019

Treatment	Growth Percentage (%)			TSS Seed Height (cm)			Number of leaves		
	14 DAS	25 DAS	40 DAS	14 DAS	25 DAS	40 DAS	14 DAS	25 DAS	40 DAS
P1	93.90 b	87.50 c	82.50 c	9.60 ab	11.80 b	13.35 c	2.00 a	2.20 a	2.40 a
P2	98.60 a	94.70 ab	89.50 b	10.40 a	12.25 b	14.50 b	2.20 a	2.50 a	2.60 a
P3	0.00 d	0.00 d	0.00 d	0.00 c	0.00 d	0.00 d	0.00 b	0.00 b	0.00 b
P4	6.00 c	0.00 d	0.00 d	9.40 ab	0.00 d	0.00 d	2.00 a	0.00 b	0.00 b
P5	98.20 a	96.60 a	93.50 a	10.30 a	14.85 a	19.30 a	2.00 a	2.40 a	2.60 a
P6	97.80 a	92.50 b	89.50 b	9.20 b	10.30 c	13.60 c	2.00 a	2. 20 a	2.40 a

Note: The numbers in the same column followed by the same letter were not significantly different at the 5% level based on the DMRT test; DAS: Day After Seeding

The lowest growth percentage was achieved by nursery in the seedling boxes (P3) with seeding media: 100 percent soil and cover of grooves using granular organic fertilizer. Closure of the TSS seed grooves using granular organic fertilizer caused TSS seeds not to grow at all, presumably because the organic fertilizers caused heat in the seeding media so that the seeds did not germinate. At the age of 14 DAS to age 40 DAS, no TSS shallot seeds grow (zero percent). The second lowest percentage of growth was nursery in seedling boxes with seeding media: 100 percent soil and cover grooves using wet sawdust (P4). The percentage of growth at the age of 14 DAS was only 6 percent, and at the age of 25 DAS and 40 DAS the TSS seeds that had grown had died (growth percentage was zero percent). The use of wet sawdust causes a fungus to interfere with growth and kill TSS seeds.

The results of the field study showed that the use of a grooves cover greatly determined the growth percentage of TSS seed produced. Covering the seed grooves using soil (P1), caused the seeds to tend to be densely covered and the process of seeds germinating takes longer and it was difficult to penetrate the soil to grow, compared to covering the grooves using cocopit, which tends to have a soft and loose texture, making it easier for seeds to grow.

In this study, TSS shallot seeding were also tested on raised beds without paranet hoods (treatment of P6). The growth percentage of TSS shallot seeds until the age of transplanting (40 DAS) was very good, reaching 89.50 percent. TSS shallot seeding using this method (P6) is recommended to be carried out in the dry season, because if it is done in the rainy season it will damage and kill the TSS seeds during heavy rains because there is no hood to protect the nursery. The results of this study also indicated that TSS shallot seeds have the potential to be planted directly, but require intensive attention and maintenance so that the growth percentage of seed remains high. This is considering the research of [19], that the growth percentage of TSS shallots directly planted on land was still very low, only about 50 percent.

The analysis results in table 1 also showed that the growth percentage of TSS seed tended to decrease from the age of 14 DAS to the age of transplanting (40 DAS). The mortality of TSS shallot seeds based on field studies, was more caused they were not resistant to the sun's heat, so the seeds become dry and die. The results of the study also showed that the success of TSS shallot seeding was determined by the media used for the seedings. According to [20] stated that the adaptability or growth percentage of seeds from TSS in the field was influenced by differences in seeding media that provide different growing environments for plants. The growth percentage of TSS shallot seeding in this applied study was higher than the growth percentage of TSS shallot seeding that had been done by cooperator farmers in 2018. The growth percentage of TSS shallot seed carried out by cooperator farmers previously only reached ± 40 percent.

From table 1, it can be seen that the treatment of seeding media had a significant effect on TSS seed plant height. The result was in line with the research of [21] that the composition of the seeding media had a significant effect on the length (height) of the plants during the TSS shallot seeding. The results showed that the highest TSS seed plant height from the age of 14 DAS to the age of 40 DAS was seeding in raised beds with seeding media: soil, granular organic fertilizer, cover grooves using cocopit and using paranet hoods (P5). The height of TSS seeds aged 14 DAS, 25 DAS and 40 DAS were 10.30 cm, 14.85 cm and 19.30 cm respectively. Even though it produced the highest TSS seed plant height, most of the TSS seed stems in this treatment (P5) experienced incline (inclined), presumably due to frequent large wind gusts at the location of the applied study that hit the nursery on the raised beds and possibly due to the use of paranet hoods that too low, so that the nursery darkens and reduces the sunlight that TSS seeds receive. The second highest TSS seed plant height was in the seed box with 100 percent soil seeding media and groove cover using cocopit (P2). TSS seed height at transplanting age (40 DAS) reached 14.50 cm.

In TSS shallot seeding using seedling boxes with 100 percent soil media and cover grooves using cocopit (P3), seed height 0.00 cm from the start to transplanting because of no TSS seeds grew (zero percent seed growth percentage). TSS shallot seeding in raised beds without paranet hoods (P6), the TSS seed height was the lowest relative to other treatments from the start until transplanting. Despite having delayed growth and shorter TSS seed heights compared to other treatments, the appearance of TSS plants/seeds in open raised beds without paranet hoods (P6) resulted in TSS seeds with sturdy, large, upright stems. This is presumably because TSS seeds have adapted to the sun's heat since the beginning of seed growth in the seeding.

In terms of the number of leaves produced in this TSS shallot seeding, the highest number of leaves was seeding in seedling boxes with 100 percent soil media and cover grooves using cocopit (P2), with an average number of leaves from the ages of 14 DAS, 25 DAS, and 40 DAS respectively: 2.20 leaves, 2.50 leaves and 2.60 leaves. However, the results of the analysis showed that the number of leaves produced was not significantly different from the treatment of P1 (seeding using a seedling boxes with soil groove cover), P5 (seeding on raised bed area with paranet cover) and P6 (seeding on open raised bed without paranet cover). In the P3 and P4 treatments the number of leaves was 0.00 because of no seeds grew. Thus, if these two treatments were neglected because of no seeds were growing, then based on the analysis, the treatment of seeding media was not significantly different from the number of TSS seed leaves produced during the seeding. It was in line with the research of [20, 21] stated that seeding media had no significant effect on the number of TSS seed leaves during seeding.

The analysis results from table 1 can be seen that overall (in terms of growth percentage, plant height and number of leaves), the best TSS shallot seeding was the seeding on raised beds with seeding media: soil, granular organic fertilizer, groove cover using cocopit and paranet hood (P5). When comparing TSS shallot seeding in raised beds and screen houses using seedling boxes, the appearance of plants (TSS seeds) in seeding in raised beds tends to have larger, stronger stems and faster growth compared to seeding in seedling boxes which tend to have small stem. This was presumably caused the seeding in raised beds allowed TSS seeds to had long and strong roots so that they get more water and nutrients compared to seeding using seedling boxes with limited soil media thickness so that the resulting roots were also shorter and were limited in absorbing water and nutrients for seed growth. Seeding on raised beds was more cost efficient, while screen-house nursery require a larger initial investment cost. However, a screen house seeding using a seedling boxes has the advantage that farmers can do the seeding at any time, is not affected by the weather, either in the dry season or in the rainy season, and is more practical in maintenance.

3.2 Technical application of transplanting TSS shallot

When the TSS shallot seeds in the seeding were 40 days old, the TSS shallot seeds, both in the seedling boxes and in the raised beds, were transplanted in the previously prepared planting areas. The land for planting shallots was made of beds according to the size of the land. In this study, planting beds were made with a width of ± 120 cm and a length of ± 25 meters, with a distance between beds of ± 40-50 cm. Before the TSS shallot seeds are transplanted, the beds were first watered/irrigated to provide soil moisture.

The TSS seeds in the nursery at the age of 40 days after planting (DAP) were removed slowly so that the roots did not broken. To avoid breaking and damaging the roots, it is best to first water it in the nursery to facilitate uprooting. The TSS shallot seeds that had been pulled were then immediately transferred to the planting location (planting raised land). The number of plantings that were applied in this study location was 2-3 plants per planting hole.

To compare plant growth, in this study, shallots were also planted using tuber seeds, the Bauji variety. The planting of shallots using these tuber seeds were carried out in conjunction with the planting of TSS shallots. When transplanting, TSS shallot seeds usually experience unrest due to the stress of the transplanting process. At the age of 2-3 DAP, the transplanted TSS shallot plants will begin to grow upright. The growth percentage after transplanting of TSS shallot from the seeding in the location of this study was relatively high, reaching more than 80 percent (table 2). The growth percentage of TSS seed resulted from the seeding in the seedling box (83 percent), was lower than the percentage of TSS seed grown in raised beds (up to 91 percent).

Table 2. Growth percentage of TSS shallot after transplanting in Ilomangga Village, Tabongo District, Gorontalo Regency in 2019.

No	Type	Growth percentage after transplanting (%)
1	TSS shallot seeds from a seeding in the seedling box	83
2	TSS shallot seeds from a seeding in the raised beds	91
3	Shallots from tuber seeds	97

The growth of TSS shallots from seeding using seedling boxes and seedings on raised beds also showed a difference. The growth of TSS plants after transplanting resulted from seedings on raised beds, where the plants grew firmly and showed rapid plant development. This was different from the growth of TSS plants produced by seedings in seedling boxes, where more transplanted plants experience death due to small leek stalks, so they cannot stand the sun's heat. The small stems of the leaves resulting from the seedings in the seedling boxes awere due to the small thickness of the seeding media, so that the availability of nutrients needed for seed growth was also limited. In addition, it was also influenced by the lack of additional fertilizers (nutrients) during the seeding. Another study, [12], revealed that visually the growth of shallot plants from TSS tended to be uniform, there was no significant difference between plants from different media.

Maintenance of TSS shallots includes irrigation, replanting dead TSS shallots in the land, controlling weeds and fertilizing. Watering shallot in this study was carried out regularly every 1-3 days once due to the long dry season and no rain (in July-October 2019). The very high heat from the sun results in TSS shallots with small stems not heat resistant, so they die. The dead plants were replanted with TSS seed reserves from the seeding. For weed/grass control, manual weeding and spraying using selective herbicides regularly depend on weed conditions. The fertilizer dose applied in the assessment of TSS shallots at this location was NPK Phonska of 850 kg per ha. Fertilization application was carried out twice, at the age of 14 days after planting (DAP), and at 30-40 DAP.

3.3 Growth and yield performance of TSS shallot technology

To determine the growth performance of TSS shallot after transplanting, periodic observations were made at the age of 20 days after planting (DAP), 40 DAP, and 50 DAP which included plant height, number of tillers and number of leaves. As a comparison, this study also planted red onions from the Bauji variety tuber planted together with TSS shallots. The growth performance of TSS shallots and tubers shallots in Ilomangga Village, Tabongo District, Gorontalo Regency, Gorontalo Province can be seen in table 3.

Table 3. The growth performance of TSS shallots and tuber shallots in Ilomangga Village, Tabongo District, Gorontalo Regency in 2019.

Treatment	Observation Variable								
	20 DAP			40 DAP			50 DAP		
	PH	NT	NL	PH	NT	NL	PH	NT	NL
TSS Shallots (Trisula Variety)	21.70	1.00	4.90	38.60	1.10	6.20	40.60	1.20	7.10
Tubber Shallots (Bauji Variety)	24.70	6.25	25.50	35.50	7.79	31.60	37.50	8.90	35.60

Note : DAP = Day After Planting; PH = Plant Height (cm) ; NT = Number of Tillers; NL = Number of Leaves

In terms of plant growth performance, the Trisula variety TSS shallot had different growth from the Bauji variety in terms of plant height, number of tillers and number of leaves from the age of 20 DAP, 40 DAP and 50 DAP. From the average plant height, the TSS shallots tended to be higher than the height of the shallots from the Bauji variety at the age of 40 DAP and 50 DAP. The height of TSS shallot plants at the age of 50 DAP reaching 40.6 cm, while the tuber shallots were 37.50 cm. However, from the number of tillers and the number of leaves, TSS shallots had a much smaller number of tillers and leaves compared to tuber shallots at the age of 20 DAP, 40 DAP and 50 DAP. The average number of TSS tillers at the age of 50 DAP was 1.20 tillers, while the shallots from tubers were 8.97 tillers. The number of leaves produced by TSS shallots was still low, where the average number of TSS of leaves at the age of 50 DAP was only 7.10 leaves, while the tubber shallots reaching 35.60 leaves. However, from the results of visual observations in the field, the growth of shallot plants from TSS seeds tends to be healthier, greener and less disease.

Harvesting TSS shallots at the location of the applied study was carried out at the age of 70 DAP, while for shallots from tubers, harvesting was carried out at the age of 60 DAP. The age of harvesting shallot from TSS seeds was different from the age of harvesting shallot from the tubers. Shallots from TSS seeds had a longer harvest life, compared to those from tubers. The performance of TSS shallots in Ilomangga Village, Tabongo District, Gorontalo Regency in 2019 is presented in table 4.

Table 4. The yield performance of TSS shallots in Ilomangga Village, Tabongo District, Gorontalo Regency in 2019

Treatment	Observation Variable				
	Number of Tuber	Tuber Diameter (mm)	Tuber Weight (gram)	Tuber Weight per Hill (gram)	Tuber Productivity (kg/ha)
TSS Shallots (Trisula Variety)	1.20	32.4	18.10	20.45	4 900
Tubber Shallots (Bauji Variety)	8.50	21.77	4.67	39.70	6 250

From the harvest, it was known that TSS shallot had different yield components compared to those from tubers. The average number of tubers produced by TSS shallots were only 1.20 tubers, while the tuber shallots were up to 8.50 tubers. However, TSS shallots were superior in terms of diameter and weight per tuber produced than shalots from tubers. The productivity of TSS shallot Trisula variety was 4 900 kg/ha, still lower than the tuber shallot that reaching 6 250 kg/ha, due to the small number of tillers and the number of tubers produced by TSS shallots. The low productivity of TSS shallots was also influenced by the lack of production inputs used, both organic and inorganic fertilizers, and the spacing was not optimal. The increased growth and yield of TSS shallots can also be accomplished by the application of salicylic acid as was found [22].

The results of the previous study indicated that the tuber yield from TSS shallot harvest, used as tuber seeds for the next season, had excellent growth, produced a large number of tillers and high productivity. Tubers produced from TSS shallots also have superior characteristics in terms of color and tuber size. According to [3], seeds from TSS have advantages in terms of resistance to diseases, especially viruses that usually transmitted through tubers. TSS seeds have a longer life span and shelf life, and do not have a dormancy period so they are more flexible to use whenever needed, in contrast to tuber seeds that can be planted for 2-3 months and have a physiological age of about 4 months, which if the planting is delayed, the seeds will be damaged. The need for TSS seeds is only slightly ranging from 3-7.5 kg / ha, thereby reducing production costs. Small and dry seeds physically do not require a large storage area, are easy to transport and are cheaper to transport.

3.4 Farmers' perceptions of TSS shallot technology

One of the evaluations of agricultural innovation applied study activities is to find out farmers' perceptions of applied technological innovations. In this study, the measurement of farmers' perceptions of TSS shallot technology was carried out. The results of measuring farmers' perceptions of TSS shallot technology in Ilomangga Village, Tabongo District, Gorontalo Regency are presented in table 5.

The analysis showed that most of the respondent farmers (> 60 percent) stated that the application of TSS shallot technology was able to increase production, and 80 percent of the respondent farmers stated that the TSS shallot technology was able to increase farmers' income. This TSS shallot technology was better used for the production of shallot tuber seeds, as a planting material for the next season. The results of the field study showed that the planting of shallot tubers from TSS had a lot of tillers, the plant's physical growth was very good with large and sturdy stems and leaves, and was relatively resistant to pests and diseases. From this result, many farmers responded positively and there were many requests for TSS shallots to be used as tuber seeds. According to the TSS shallot cooperator farmer, the selling price of the tuber seeds produced by the TSS shallot can reach IDR 100 000 per kg. It caused quality of the tubers of TSS results was very good, had a dark red color and a large tuber size.

Table 5. Farmers' perceptions of TSS shallot technology in Ilomangga Village, Tabongo District, Gorontalo District

No	Statement	Farmers' perceptions (%)					
		SA	A	D	DA	SDA	Total
1	The application of TSS shallot technology increases yield / production	0.00	66.67	26.67	6.67	0.00	100
2	The application of TSS shallot technology increases farmers' income	33.33	46.67	20.00	0.00	0.00	100
3	TSS shallot technology is easy to implement by farmers	0.00	6.67	20.00	73.33	0.00	100
4	TSS shallot seeds are easily available at farm shops/seed distributors or seed breeders	0.00	6.67	6.67	80.00	6.67	100
5	TSS shallot technology produces quality tuber seeds	80.00	20.00	0.00	0.00	0.00	100
6	Farmers are interested in applying TSS shallot technology again	0.00	60.00	40.00	0.00	0.00	100
7	TSS shallot seeding is easy to apply	0.00	20.00	6.67	6.67	66.67	100
8	The application of TSS shallot technology saves production costs	6.67	66.67	20.00	6.67	0.00	100
9	TSS shallot planting is easy to do	0.00	60.00	6.67	33.33	0.00	100
10	Maintenance of TSS shallots after transplanting is easy	0.00	13.33	13.33	66.67	6.67	100

Note: SA = Strongly Agree; A = Agree; D = Doubt; DA = Disagree; SDA = Strongly Disagree

Farmers also stated that the application of TSS shallots was able to save production costs, caused the seeds used were fewer and cheaper than using tubers. The use of TSS shallot seeds only requires 5-7 kg/ha whereas if using shallot tuber seeds, it takes around 1,000-1,500 kg/ha. In addition to saving seed costs, it also saves the cost of transporting seeds. With this savings in production costs, it will increase the profits and income of shallot farmers. However, in terms of ease of application, most farmers (> 70 percent) of farmers stated that the TSS shallot technology was not easy to apply, especially in terms of implementing TSS shallot seedings and maintenance after the transplanting process. TSS shallot seedings require intensive monitoring and maintenance, and require the timely application of technology and the right dose. The successful application of TSS shallot technology was determined by the successful application of seeding process and plant maintenance after transplanting. In terms of planting, farmers were also relatively unfamiliar with the transplanting process of TSS shallot seeds.

From the survey results, it can be seen that farmers (60 percent) expressed their interest in re-implementing the TSS shallot technology, and 40 percent stated that they were still not sure (doubt) to re-implement it. According to farmers, the implementation of TSS shallot technology required intensive assistance from field officers. Farmers gave a positive response and were interested in TSS shallots after seeing for themselves the results of planting in the following season from the previous TSS production, showing very good plant growth and better yields. However, the government through the agriculture agency needs to support the provision of TSS seeds, because from the results of this study, it was found that farmers had difficulties in obtaining TSS seeds both at farmer shops, seed distributors and at seed breeder level. The availability of TSS shallot seeds is still limited in Gorontalo, so it is necessary to grow TSS shallot seed breeders and develop sustainable shallot seed logistics.

From the results of the applied study of TSS shallot technology, it showed that cooperator farmers had been able to apply TSS shallot seedling technology either using seed boxes in screen houses or direct seedling on raised beds. The growth percentage of TSS shallot seeds at the seeding stage and after the transplanting process was quite successful compared to the previous season, where the growth percentage after transplanting was quite high (> 80 percent). The successful application of TSS shallot technology at the location of this applied study could be the forerunner of the growth of quality shallot seed producers in Gorontalo, so that they can contribute to the provision of quality and sustainable seeds in the future of Gorontalo Province.

3.5 Farm financial analysis

The results of the financial analysis of TSS shallot farming in Ilomangga Village, Tabongo District, Gorontalo Regency can be seen in table 6. The analysis results showed that the revenue of TSS shallot farming was IDR 122,500,000 assuming the selling price of consumption shallots at the farmer level was IDR 25,000. The revenue of TSS shallot farming was still lower than that of shallot farming using Bauji variety tuber seeds, with an revenue of IDR 156,250,000. The revenue of TSS shallot farming was lower because the productivity of TSS shallots in the applied study site was 4,900 kg/ha, while the productivity of shallots from tubers was 6,250 kg/ha. However, in terms of production costs, TSS shallot farming produced a much lower production cost than tuber shallot farming. The total TSS shallots production cost per hectare was IDR 28,749,000 while the total production cost of shallot tuber farming was IDR 64,164,000. Production cost savings were more than 50 percent. The biggest savings in TSS shallot production costs were in the cost of seeds. The cost of TSS shallot seeds per ha was only IDR 10,000,000 while if using tuber seeds it was IDR 50,000,000. With this much lower production cost, the profits of TSS shallot farming were still higher when compared to the profits of shallot farming from tubers. The profit on the total cost of TSS shallot farming was IDR 93,751,000 while the profit on the total cost of onion farming from tubers was IDR 92,086,000.

In terms of revenue and cost ratio (R/C ratio), both TSS and shallot from tubers produced an R/C ratio > 1, which means that both TSS and shallot from tubers are efficient to run. However, the R / C ratio of the TSS shallot farming (4.26) was higher than the R/C ratio of the tuber shallot (2.44). This result was in line with the research of [3, 2, 14]. According to [9], the use of TSS was economically feasible because it can doubled the yield of using shallot tubers.

Table 6. Financial analysis of TSS shallot farming in Ilomangga Village, Tabongo District, Gorontalo Regency.

Description	TSS Shallot Technology		Tuber Shallot Technology	
	Value (IDR/ha)	%	Value (IDR/ha)	%
Tuber production (kg)	4 900		6 250	
Selling price per kg	25 000		25 000	
Revenue	122 500 000		156 250 000	
Cash fee:				
Seed	10 000 000	34.78	50 000 000	77.93
Seeding	4 500 000	4.72	-	0.00
Growth stimulants	85 000	0.09	-	0.00
Phonska fertilizer	1 840 000	6.40	1 840 000	2.87
Insecticide	800 000	2.78	800 000	1.25
Herbicide	700 000	2.43	700 000	1.09
Outside family labor	9 300 000	32.35	9 300 000	14.49
Cost calculated:				
Family labor	1 500 000	5.22	1 500 000	2.34
Equipment depreciation	24 000	0.08	24 000	0.04
Total cash cost	27 225 000	94.70	62 640 000	97.62
Total cost	28 749 000	100.00	64 164 000	100.00
Profits over cash cost	95 275 000		93 610 000	
Profit over total cost	93 751 000		92 086 000	
R/C on cash cost	4.50		2.49	
R/C on total cost	4.26		2.44	

4 Conclusion and suggestion

4.1 Conclusion

The best TSS shallot seeding was obtained in raised beds with paranet cover (P5) with a growth percentage >90 percent. The results of transplanting showed that the growth of TSS shallots tended to be healthier, greener and less disease with the growth percentage of TSS after transplanting was reaching >80 percent with a productivity of 4.9 ton/ha.

The average farmer's perception of TSS shallot technology showed that TSS shallot technology was able to increase yields, save seed costs, increase farmers' income, produce quality tuber seeds and farmers tend to be interested in applying it again, but most still stated it was difficult to apply the seeding process and maintenance after transplanting.

The results of farming financial analysis showed that TSS shallot farming produced a revenue-cost ratio (R/C ratio)>1, which means that TSS shallot farming was efficient to run. The profit and R/C ratio of TSS shallot farming was higher than that of tuber shallot.

4.2 Suggestion

Further research is needed to test more low-cost and easy-to-get TSS seeding medias for farmers to obtain technical recommendations for efficient and effective TSS shallot seedings. The successful application of TSS shallot technology is very much determined at the stage of seeding and plant maintenance after the transplanting process, so this phase needs intensive attention and maintenance by farmers.

The development of the implementation of TSS shallot technology is also very much determined by the availability of TSS shallot seeds both in farm shops and in seed breeders, when farmers need them, so it is necessary to develop adequate TSS seed logistics and development of TSS seed breeders in the shallot area.

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