PROSPECT FOR FARMERS' ADOPTION OF TRUE SHALLOT SEED

Prospek Adopsi Benih Botani Bawang Merah oleh Petani

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ABSTRAK

Upaya peningkatan produksi bawang merah ditempuh melalui Program Lipat Ganda (PROLIGA) bawang merah dengan adopsi biji botani bawang merah atau *True Shallot Seed* (TSS) karena berbagai kelebihan, antara lain biaya benih murah, volume benih lebih sedikit, lebih tahan lama disimpan, dan potensi hasilnya lebih tinggi. Makalah ini bertujuan mengulas prospek adopsi TSS oleh petani berdasarkan ulasan *(review)* berbagai publikasi dan laporan hasil penelitian maupun proyek percontohan. Produksi TSS di Indonesia belum pada skala komersial, tetapi masih dalam skala percobaan. TSS yang digunakan untuk pilot proyek merupakan benih impor karena produksi TSS di dalam negeri masih sangat terbatas. Petani umumnya lebih memilih menanam umbi mini dibanding TSS karena masa tanam yang lebih singkat. Pada taraf tertentu potensi hasil TSS lebih tinggi dari benih umbi. TSS memiliki beberapa kelemahan, yaitu perlu pesemaian 5−7 minggu, daya tumbuh TSS menjadi umbi mini relatif rendah, dan penyakit yang membuat batang tanaman tumbuh bengkok. Penanaman bawang merah menggunakan TSS memerlukan waktu lebih lama dibanding menggunakan umbi mini maupun umbi. Peningkatan skala produksi untuk pasokan TSS di dalam negeri dan jaringan produsen umbi mini dengan petani akan dapat meningkatkan adospi TSS.

Kata kunci: *adopsi, bawang merah, biji botani, hasil, umbi mini*

ABSTRACT

The effort to enhance shallot production was carried out through Shallot Double-Fold Program (PROLIGA *Bawang Merah*) using TSS (true shallot seed) for some advantages, i.e. lower seed cost and volume, lasting longer for storage, and potential higher yield. This paper aims at reviewing the prospect of farmers' TSS adoption. The methodology of this study was based on a review of research publications of TSS and pilot project results as well as those of technical reports, TSS production in Indonesia is not yet at commercial scale, but still produced at a research level. TSS varieties adopted for the pilot projects are those imported ones due to limited local TSS production. Most shallot farmers adopting TSS varieties prefer planting mini bulbs rather than TSS for a shorter growing period. To some extent, TSS potential yield is higher than that of bulb seeds. However, before transplanting to farmland the TSS nursery takes time, and lower growth rates from TSS to mini bulbs, and twisted disease. Adopting TSS for shallot production potentially increases yield, but it takes longer to plantTSS to bulb harvest compared to the adoption of a mini bulb and bulb seed. Enhancing TSS production for domestic seed supply and a link between mini bulb growers will improve TSS adoption.

Keywords*: adoption, mini bulb, shallot, true shallot seed, yield*

INTRODUCTION

Shallot is one of the important vegetables to Indonesian households besides chili. It is usually consumed fresh or processed first as fried shallot. Fluctuating shallot price is due to its seasonal production, and this commodity is considered as the inflationary one (Kementerian Perdagangan 2016). Shallot price in January 2020 increased by 18.91% compared to that in 2019 (Bank Indonesia 2020). Thus, The Ministry of Agriculture in 2016 launched a program to expand domestic shallot production called PROLIGA or Shallot Double-Fold Program (Suwandi et al. 2016).

The farmers grow shallot in some regions in the country. The total harvested area of shallot in Indonesia in 2018 was 120,704 hectares, with its production of 1,503,436 tons or an average yield of 12.36 tons per hectare. Most of shallot is produced in some provinces, i.e., Central Java (519,356 tons), East Java (293,179 tons), West Nusa Tenggara (117,513 tons), West Java

(130.082 tons), and West Sumatera (61,335 tons) (BPS 2018).

Shallot farming costs deal with unstable shallot bulb prices as determined by the retail price of shallot during planting season. The cost of bulb seed in shallot farming can be as low as 30 percent of total cost production (Rachmat et al 2014). However, bulb cost share may soar to more than 50 percent of shallot farming total cost when shallot retail price was expensive (Hakim et al 2017). Most farmers in the country use the bulb as shallot seed as it is quickly grown, and it takes around 65 to 70 days for harvest. On the other hand, adopting true shallot seed (TSS) for shallot growing is still rarely found. Planting TSS needs longer harvest time, i.e. around 90-100 days.

The advantage of using TSS includes its much lower seed cost compared to that of bulb seed. Shallot crop grown from TSS has a good establishment, higher yield, free of pests and diseases, lower volume of seed, cheaper production cost, and no special transport and storage for TSS (Askari-Khorasgani and Pessarakli 2019; Maintang et al. 2019). However, it needs time and extraordinary effort to change farmers' habits from using conventional bulbs (bulblet) to TSS as the planting material.In the end, practical and economic aspects will be the determining factors toward TSS adoption.

TSS is already produced and marketed by some seed producers but farmers' responses are limited. The Indonesian Center for Horticulture Research and Development announces that three varieties of shallot, namely Bima Brebes, Kuning, and Keling (Maja) are suitable for TSS propagation. To produce TSS successfully some factors are crucial, namely variety, physiology of bulblet, right practice and suitable local climate, and reliable human resource. TSS production in Indonesia should also deal with limited day length and unsuitable temperature (Sopha 2014). In addition, there is no large-scale local TSS production (Pangestuti and Sulistyaningsih 2011). This paper in general was aimed at reviewing farmers' adoption of TSS. Specifically this paper aims: (i) to assess TSS production and its supply chain, (ii) to evaluate farmers' practices for growing shallot using TSS, and (iii) to compare shallot farmers' profit using TSS and bulb seed. This paper was written based on a review of publications of research results and pilot projects as well as technical reports related to either laboratory and field experiments as well as farm surveys.

TSS PRODUCTION AND SUPPLY CHAIN

TSS production is still relatively limited, carried out by the research institution, notably Indonesian Vegetable Research Institute (IVEGRI) in Lembang, West Java Province. Most locally produced TSS is aimed at meeting demands for research and pilot projects. The TSS seed producers, i.e. PT East-West Seed Indonesia and PT Agrosid Manunggal Santosa, just imported the seed and distribute it to the local market, usually through collaborating with government institutions.

TSS Production

From 2007 to 2012, a TSS production experiment was conducted in the lowland farm area in Brebes Regency, Central Java, using Tuk, hybrid, and local TSS varieties for evaluating the plant densities. It was a collaboration between Wageningen University and Research and IVEGRI (Van den Brink and Basuki 2012). The research showed that Sanren variety had lower plant density than Tuk Tuk in producing TSS. An experiment of producing TSS in lowland in Subang Regency, West Java Province, was conducted by Kurniasari et al. (2017). This study assesses the uses of plant growth hormone (BAP) and pollinating insects, i.e. *Apis cerana.* Both treatments significantly improved TSS production. Another experiment was conducted by Agung and Diara (2017) on pre-sowing treatment. It indicated that the pre-sowing application of growth hormone (GA3) significantly enhancing the germination rate and growth vigor of TSS.

The use of quality seed from improved shallot seed is the key to achieving high shallot production at the farm level. TSS is expected as a quality shallot seed at relatively low in price. Commercial production of TSS in the country, however, has not been realized yet. All TSS varieties production is still under experiment in Indonesia, and government support is critical (Rosliani 2015). TSS varieties sold commercially were produced abroad and imported by some seed producers to meet domestic demand. TSS is possibly produced in highland where lower temperature takes place. TSS production in lowland resulted in the worse outcome as the temperature was quite high regardless some of treatments, e.g. seed vernalization and growth hormone, were applied (Widiarti et al. 2017).

Early 2015 the AARD, namely Indonesian Vegetable Research Institute (IVEGRI) produces two new varieties of TSS, i.e. Agrihort

1 and Agrihort 2, which were released in 2014 based on The Minister of Agriculture Decrees (Kepmentan) No 15 and 16 in 2015, respectively. Both new TSS varieties are claimed to be better off than those Maja and Bima varieties. Agrihort 1 and Agrihort 2 are produced through parental crossing and variety purity tests and also field trials. On the other hand, TSS Maja and TSS Bima are produced from shallot seed grown from bulbs. Shallot flowering is conducted on highland and needs six months, such as carried out by Assessment Institute for Agricultural Technology AIAT) in East Java. Nevertheless, a shallot farmer in Nganjuk Regency, East Java, produced TSS from shallot grown from a bulb in less than 90 days after planting. The other shallot varieties also produce TSS are Trisula, Pancasona, Maja Cipanas, and Mentes.

Flowering and seed production trials from varieties shallot Bima Brebes, Kuningan, and Keling (Maja) were conducted in Brebes and Tegal Regencies, Central Java. From those three varieties, the researcher could produce 11 lines. A commercial TSS variety, namely Tuk-Tuk, was also tried. Trials were conducted in lowland (Subang) and highland (Lembang) using BAP and boron to assess their effects on flowering, pollen viability, production, TSS seed quality (Suwandi, 2010). So far, the most commercial TSS distributed to farmers are Sanren and Lokananta imported by PT East West Seed Indonesia and PT Agrosid Manunggal Santosa. On the other hand, local TSS varieties such as Agrihort 1, Agrihort 2, Maja, Trisula, among others, are still grown under the experimental level.

In Indonesia, low production of TSS per shallot clump is the main reason that local TSS varieties have not yet been produced commercially. A field experiment for producing TSS from Trisula variety conducted by Prahardini and Sudaryono (2018) in Batu Municipality, East Java, showed that the yield was 11.5 kg per 1,000 m2 TSS on average. It needed six months from planting TSS to harvest. The pollinating insects such as honey bees, forest bees, and green flies were essential. Pests and diseases attack was significant during the vegetative and generative growth phases. Controlling those pest and disease was detrimental to pollinating insects. Even though The TSS yield was good enough at the experimental level, it was not practiced on a larger scale.

A field experiment using four different shallot varieties, i.e. Trisula, Pancasona, Maja Cipanas, and Mentes, to produce TSS was conducted in Jeneponto Regency, South Sulawesi, by Nurjanani and Djufry (2018). The Experiment was conducted for six months (March-September 2015) with areas of 500 m2 for each variety. The results indicated that Trisula and Pancasona varieties had more flowering rates and produced higher TSS than those of Maja Cipanas and Mentes varieties. Given the TSS yield of 4.90 grams and 4.18 grams per clump of Trisula and Pancasona varieties, respectively, were considered as a potential for scale-up production.

Kiloes et al. (2016) conducted the demonstration farms in two highland villages in Enrekang Regency, South Sulawesi Province. The first demonstration farm (500 m2) was producing TSS with Bima, Maja, and Sembrani varieties adoption. The second demonstration farm (72 m2) was growing mini bulbs for shallot production. TSS yield of the first farm was 1.8 kgs. Mini bulb yield of the second farm was 78.06 kgs including those in farmers' land but no area size specified. Most of farmers interested in producing TSS and growing mini bulbs. Future challenges to adopt TSS were the establishment of TSS, mini bulb, and bulb seed producers in this regency.

A multi-location trial was carried out by Sembiring et al. (2018) in North Sumatera, Central Java, and East Java at 1,000-1,500 meters above sea level to produce TSS with no variety specified variety. Experimental areas were 500 m2, 1,000 m2, and 1,000 m2 in North Sumatera, East Java, and Central Java. The TSS yields were 32 kgs per 500 m2 in North Sumatera, 11.5 kgs per 1,000 m2 in East Java, and 3.5 kg per 1,000 m2 in Central Java. It seemed that TSS production in North Sumatera and East Java were promising at the experimental level, but not in Central Java. Low humidity and abundant pollinating insects were the determining factors of high yield TSS in North Sumatera. East Java had relatively high rainfall during shallot growing season despite low how humidity and controllable pest and disease attack. Central Java experienced bad weather during TSS production experiment, namely high rainfall, and strong wind.

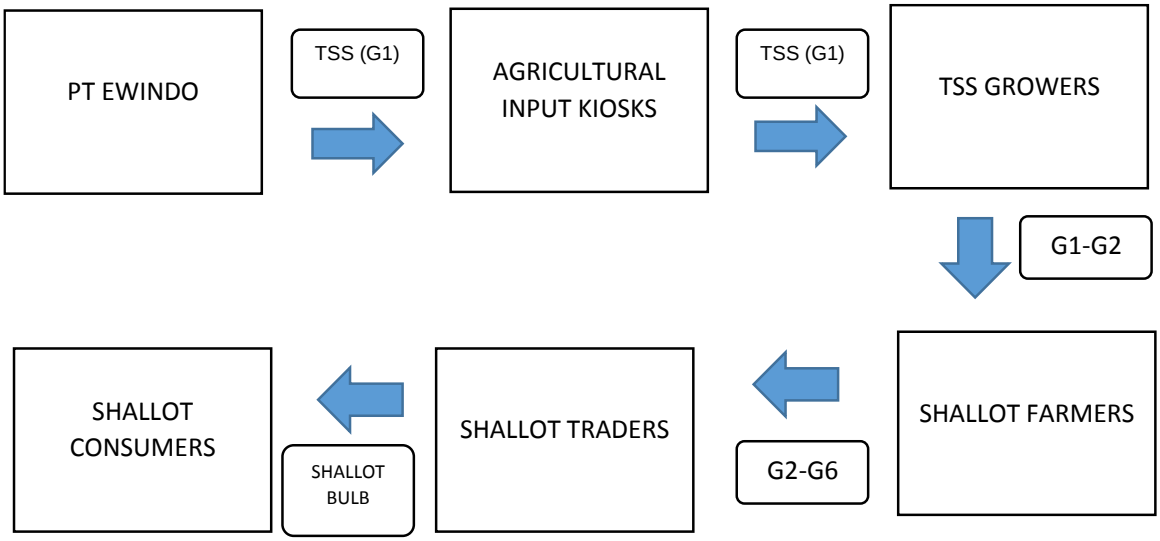

Figure 1. Model-1 Supply Chain of TSS and Mini Bulb (PT East West Seed Indonesia, 2015)

In 2014 Rosliani et al. (2018) conducted an experiment to produce TSS in Lembang, West Java using Brebes TSS variety. Two technology packages were tried, i.e. package A consisted of horse manure 10 tons/ha, chicken manure 5 tons/ha, BAP, and Boron fertilizer. Package B comprised horse manure of 20 tons/ha, NPK of 600 kgs/ha, and GA3 (growth hormone). Variables such as crop height, flower clusters, and several seeds indicated that package A was better off than that of package B. However, both packages were good enough and potential for scale-up production.

TSS Supply Chain

Very few TSS is sold to the farmers based on the market mechanism. Some TSS is purchased for experimental purposes. Most of the current TSS marketing is through collaboration between the TSS distributors with The Ministry of Agriculture. For example, Directorate General of Horticulture, Ministry of Agriculture Indonesia, granted TSS to the farmers in Nunukan Regency, North Kalimantan Province, for shallot production (Direktorat Jenderal Hortikultura 2018). The other case was carried out by Universitas Swadaya Gunung Jati (UGJ) Cirebon in collaboration with the farmers' group in Indramayu Regency, West Java Province, for testing three varieties of TSS distributed by PT East West Seed Indonesia, i.e. Tuk Tuk, Lokananta and Sanren (radarcirebon.com 2019).

Rarely farmers buy TSS, grow it in a nursery or seedbed and then plantit on to the farmland. The farmers usually buy mini bulbs from seed growers as seedlings ready to be planted. A research collaboration between PT East West Seed Indonesia and Prisma conducted in East Java to assess a prospect for farmers' adoption of TSS revealed that Shallot farmers grow TSS Tuk-Tuk through purchase from adjacent retail kiosks at Rp 1,500,000/kg. TSS is grown in polybags with a diameter of each of 5 cm and placed under the shed *(net-house)*. The growing seed of 30-40 days is transplanted to the field. It needs 60-70 days from seed nursery to harvest the seedling of G1 (mini bulbs). Some farmers sell G1 to other farmers who need seed. Some G1 is propagated into G2 and sold to other farmers as seed. Farmers grow G1 or G2-G6 (bulb seeds) for shallot production and sell them to the traders, such as depicted in Figure 1 (PT East West Seed Indonesia 2015). Farmers growing G0 into G1 usually are not interested use it for consumed shallot. Most farmers think it will be too expensive if they have to buy G1 or produceTSS into G1 every season.

Another type of model-1 is model-2, namely shallot farmers buy TSS from the kiosks, but they do not grow it in the nursery. The farmers ask growers' service offered by the ornamental crop growers to grow TSS for 30 days in the polybags. Then, the grown seed in the polybag, then, is transplanted by shallot farmers to the field for 60 to 70 days and harvested as G1. In Jember Regency, the farmers transplanted seed from polybag to field intercropped with chili. Monoculture crop mini bulb is risky. The farmers grow G1 into G2. Farmers usually sell G1 to other farmers. Rarely the farmers sell G1 because farmers do not prefer it. Farmers grow G2-G6 for shallot production of G3-G7 (Figure 2).

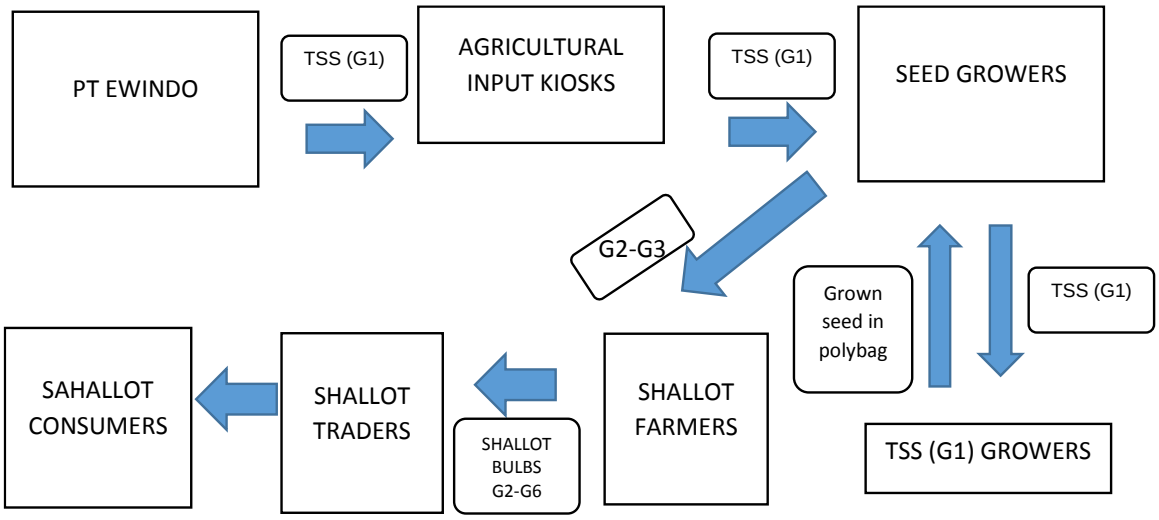

Figure 2. Model-2 Supply Chain of TSS and Mini Bulb (PT East West Seed Indonesia, 2015)

Some farmers feel safer when they grow G2-G6 for producing shallot bulb. It means the farmers grow G2 to produce G3, and some of the harvested G3 is used for seed, and the rest is sold as shallot bulb. It will be lasting until farmers grow G6, and they will repurchase G2 for seed and bulb production at the same time.

ADOPTION OF TSS AND MINI BULBS FOR GROWING SHALLOT

Most farmers producing shallot using TSS are under pilot projects of technology dissemination or collaboration with researchers for field experiments. Few farmers self-reliantly adopt TSS for shallot farming, which was usually implemented by the risk-loving farmers. Seed producers' sale promotion play an important role in disseminating TSS for commercial purposes. Some shallot production is carried out by researchers through field experiments. The other farmers grow TSS into mini bulbs and sell them to shallot farmers because growing mini bulbs are much easier for shallot production rather than growing TSS into mini bulbs and then transferring them to the farmland.

In 2013 PT East West Seed Indonesia (2015) introduced Tuk-Tuk TSS variety to the shallot farmers from many provinces in the country. Later on, they tried adopting Tuk-Tuk for growing shallot through trial and error. Some shallot farmers preferred growing TSS into mini bulbs and sold them to the shallot farmers in Java. Due to thehigh purchasing price and lack performance of mini bulbs they bought, the farmers in East Java tried growing TSS into mini bulbs by themselves or sub-contracting to the ornamental crop growers for growing TSS into mini bulbs.

Along with PROLIGA launched by the IAARD in 2016, the pilot projects and demonstration farms were initiated in some provinces. Commercial TSS varieties sold in collaboration with The Ministry of Agriculture and/or Agricultural Service Offices at regency level were Lokananta and Sanren distributed by PT East West Seed Indonesia (kabarbisnis.com 2020) and Maserati distributed by PT Agrosid Manunggal Sentosa and PT Sumbawa Superior Indonesia (bejotss.com 2018). PT East West Seed Indonesia was able to increase its TSS sale as many as 2 tons in 2018, 1.5 tons in 2019, and is expected to achieve 3 tons in 2020. TSS varieties are introduced in some provinces in Sumatra, Java, Nusa Tenggara, and Sulawesi. Recently, some shallot bulb seed producers in Brebes Regency also produce and sell TSS to shallot farmers in Central Java Province.

Planting mini bulbs (G2) is suggested by researchers for growing shallot rather than directly planting TSS (G1) as growth rates of mini bulbs are better off than those of TSS (Rosliani 2015, Sopha et a. 2015, Makziah et al. 2019). Besides, it takes 6 to 8 weeks for growing TSS into mini bulbs, which will make the cropping period last longer. Thus, some farmers prefer to buy mini bulbs and plant them into shallot. However, Maserati, i.e. a TSS variety produced by a Netherland-Based Company and distributed by the local seed distributors, is suggested either planted directly from TSS or

grown it first into mini bulbs for shallot production (bawangbejotss.com 2018).

Using the technical guidance of seedbed construction published by the Shallot Technical Team (2013) and Standard Procedure Operation by PT East West Seed Indonesia and Yayasan Bina Tani Sejahtera (2014), the TSS seed is grown on the seedbed. The seedbed width is 120-150 cm, length 20 meters, and width of water drain 30-50 cm. The seedbed could also be constructed within the net house. The TSS seed planting technique suggested by the Vegetables Research Institute also uses the 1 meter width of the seedbed, 40-50 cm height, length of the seedbed is as required, but the inter seedbed space would be 50 cm (Sumarni et al., 2014). This technical guidance, however, is not easily applied by the farmers. In general, farmers plant TSS seed in 5 cm-diameter of the polybag. These polybags will be placed in a plastic-covered net house.

So far, IVEGRI has released 11 shallot varieties and four of them potentially producing TSS, i.e. Maja Cipanas, Bima Brebes, Trisula, and Pancasona (Waluyo and Sinaga 2015). Two TSS varieties were released in 2015, namely Agrihort 1 and Agrihort 2 (Pusat Penelitian dan Pengembangan Hortikultura 2016). The Technical Guide on Shallot Double-Fold Production *(Proliga Bawang Merah)* suggests that growing shallot using TSS is carried out during the off-season, namely on the wet season (October-March). It will be better off if mini bulbs grown from TSS is planted on lowland or dryland with sand-clay, loose soil. It takes four weeks to grow TSS into mini bulbs in a nursery. After transplanting mini bulbs to farmland, the farmers have to wait for 60-70 days for harvest. It takes longer to harvest the crop in medium-altitude land and high land, i.e. each of 70-75 days and more than 80 days (Suwandi et al. 2016).

Maintang et al. (2019) experimented of growing shallot using TSS varieties, i.e. Trisula, Bima Brebes, and Tuk Tuk in Bantaeng Regency, South Sulawesi Province. TSS was grown into mini bulbs for five weeks and transplanted on to the farmland. The crop was harvested after 60 days after planting but no information when it was carried out correctly. This experiment applied three replications on the plot of 1.2 x 10 m2. The research results showed that yields of the three TSS varieties were around 7.0 tons per hectare and no significant difference among varieties.

A field experiment was carried out by Sumarni et al. (2012) in lowland in Cirebon Regency, West Java Province, using three TSS varieties, i.e. Maja, Bima, and Tuk Tuk. The highest yield was achieved by Maja variety with a density of 100 crops per m2, namely 5.15 tons dried bulb per hectare. A field experiment using Tuk Tuk variety carried out by Darma et al. (2015) in Bogor lowland showed that crop density significantly affected shallot bulb yield.

Along with Shallot PROLIGA launched by the Indonesian Agency for Agricultural Research and Development in 2016, IVEGRI introduced TSS to the farmers in some regions for shallot farming. Assessment Institute of Agricultural Technology (AIAT) in West Java Province collaborated with a farmers' group in Cirebon in 2018 applying TSS, and its yield was spectacular, i.e. equal to 42 tons of fresh bulb or 25 tons of dried bulb (Swadayonline.com 2018). IVEGRI in 2018 also conducts a field experiment of TSS. Regardless of the TSS growing rate of less than 30% and plant density less than 100 plants per m2, the yield achieved was good enough, i.e. equal to 30.64 tons per hectare (Balitsa 2018).

TSS introduction was also implemented in Bengkulu Province between The Directorate General of Horticulture and local shallot farmers on 10 hectares of farmland. TSS was grown first into mini bulbs 45 days before transplanting them to farmland (Bengkulutoday.com 2019). Agriculture and Livestock Survive in East Lombok Regency collaborated with PT East West Seed Indonesia to introduce Sanren F1 TSS variety in 2017 (Republika.co.id 2017).

FARM BUSINESS PROFIT OF USING BULB SEED *VS.* TSS IN SHALLOT FARMING

Rarely reports of farmers' practices or demonstration farms and field experiments adopting TSS described the benefit and cost analyses thoroughly. Most of land area sizes for demonstration farms were 1,000 m2 or less. On the other hand, the field experiment plot size was less than 100 m2 for one variety. A farm survey conducted by PT East West Seed Indonesia (2015) in East Java reported that farmers practiced using TSS based on the least local area size of 3,500 m2.

A field experiment of TSS varieties evaluation was conducted by Basuki (2009) in a lowland farm in Brebes Regency, Central Java Province. The plot size was 5.5 x 1.5 m2 or 8.25 m2 with three replications and then the results were converted into 1 hectare area size. The best results were achieved by Tuk Tuk variety

with density of 100 and 150 plants per m2 with shallot bulb fresh, dried yields equal to 27.19 and 32.96 tons per hectare, respectively. Each treatment spent costs of Rp 79.4 million and Rp 98.5 million with incomes each of Rp 98.2 million and Rp 115.4 million, given the shallot at farm price was Rp 3,500 per kilogram. Thus, both treatments earned profits of Rp 15.7 million and Rp 16.9 million (Appendix Tables 1 and 2). The yield of this experiment was good enough for TSS adoption, and it was achieved after several experimental seasons. From April to August 2008, when it was carried out, the growing season was ideal forthe irrigation water to be sufficiently available during dry season.

Maintang et al. (2019) conducted a field experiment assessing three TSS varieties, one bulb seed variety, and plant spacing. The experiment was based on plots with densities each of 10 x 10 cm2 and 15x15 cm2 with no area size specified. The results showed that yields of the three TSS varieties were higher than that of bulb seed. However, the yields of the three TSS varieties were not significantly different. The income and cost analysis just showed the input costs but not explicitly mentioned TSS cost. Yields of TSS varieties of Bima, Trisula, and Tuk-Tuk were equal to each of 7.450 tons/ha, 7.030 tons/ha, and 7.100 tons/ha with total incomes of Rp 149,000,000, Rp 140,600,000, and Rp 142,000,000, respectively. Profit of shallot framing of those three TSS varieties was Rp 83.4 million, Rp 75.0 million, and Rp 76.4 million per hectare for Bima, Trisula, and Tuk Tuk varieties (Appendix Table 3).

A survey of 32 farmers was carried out by Rahayu et al. (2019) in Sigi Regency, Central Sulawesi Province. The farmers grew TSS for shallot production based on a pilot project with a farmland size average of 0.62 ha. There was no TSS variety grown by the farmers. In general, the farmers were interested in planting TSS for shallot production due to the lower cost of the seed than the use of bulb seed and higher yield attained. The farmers' yield was 14.9 tons/ha with revenue of Rp 223,500,000 and net profit of Rp 153.2 million/ha (Appendix Table 4).

A farm survey carried out by PT East West Seed Indonesia (2015) in Probolinggo Regency, East Java Province, with an average farm size of 0.35 ha (1 *iring*) for growing shallot adopting Tuk Tuk variety TSS. The farmers also revealed that G1 (TSS) and G2 (mini bulbs) were used for seed purposes. In the next seasons, the farmers would plant G3 up to G7, namely some of their respective harvested bulbs, for seed. Thus, the farmers would buy TSS every seven growing seasons. TSS was planted in the polybags for 30 days and transferred to the farmland. Farmers' experience indicated that every 100 kgs of TSS Tuk Tuk (G1) could produce 10 ton of G2 (mini bulbs), a figure far above the local shallot that only produces about 7 ton from 100 kg of bulb seed. Using more than 5.7 kg of TSS per ha with an overall production cost of Rp 50.85 million anda yield of 8.6 tons/ha (Rp 171.5 million), the farmers could get profit as much as Rp 120 million per ha (Appendix Table 5). It indicated that the farmer's practice resulted in a lower yield than experiments or pilot projects.

Field experiments conducted by researchers or demonstration farms and pilot projects of TSS introduction may show promising yields with better profit than shallot bulb seed adoption. However, yields attained in field experiments or pilot projects are usually lower than those of farmers' practices. It means that farmers' practice gets lower yield than that reaches in experiments due to some factors, such as differences in farm-scale and farm management (Kravchenko et al. 2017, Affohlder et al. 2013).

Adopting a bulb seed for shallot farming is still promising, as shown by some studies based on a yield survey of farmers' practices. Rosyadi and Purnomo (2014) conducted a farm survey with 20 sample farmers in Brebes Regency. Those farmers adopted bulb seed for shallot farming with an average yield of 11.1 tons per ha. Average shallot production cost was Rp 65.3 million and revenue of Rp 70.0 million resulting in a profit of Rp 4.7 million per ha.

Another study using a farm survey, f 90 sample farmers in Nganjuk Regency, East Java province withAverage yields attained by the farmers was 12.3 tons per ha with a sale value of Rp 77.6 million. The production cost of shallot farming was Rp 49.7 million. Thus the farmers on average got a profit of Rp 27.9 million per ha. This study also revealed that the average profit efficiency of the farmers was 61.4%.

Hakim et al. (2017) conducted a study on shallot farming in-season and off-season in Bantul Regency, Yogyakarta Province, based on survey 30 farmers' survey. Average yield was 5.0 tons per ha in-season and 8.5 tons per ha off-season with production cost of Rp 85.5 million and Rp 75.6 million, respectively. On average, shallot farmers in this regency earned profits of Rp 119.2 million and Rp 105.2 million per ha, respectively. Selling price at farm level during harvest is the main determining factor of farmers' profit.

All cost and benefit analyses above showed that shallot farming adopting TSS was profitable.

The field experiment results in Brebes Regency gained the relatively lowest profits compared to the other experiments and farm surveys. Lack of TSS supply, more extended harvest period, more complicated farm practice, and low rate of TSS germination are among the reasons why most farmers have not adopted TSS at a commercial scale.

CLOSING REMARKS

Conclusion

There is no large scale of TSS production in the country for commercial purposes. Local TSS varieties are still produced in a limited scale, especially for research purposes. The seed producers imported the commercial TSS varieties sold in the domestic market due to the lower yield of TSS produced in the country. Farmers purchase TSS and grow it into mini bulbs, or they purchase mini bulb from the traders and plant them for shallot production.

TSS adoption by self-reliance farmers is limited. Most of the shallot farmers adopt TSS through collaboration with researchers or Agricultural Service Office at regency or municipality level becauseTSS, to some extent is not available in the market all year around. Low TSS adoptions are due to some factors, i.e. it takes longer to grow shallot from TSS rather than from bulb seed. The average growth rate of TSS into mini bulbs is relatively low.

The use of TSS for shallot growing seems profitable at field experiments, pilot projects, and demonstration farms. However, farmers' practice yield showed the gap compared to the experiment level. TSS requires an ideal growing season when grown during dry season and irrigation water is sufficiently available. TSS demanding environment for shallot farming limits the shallot growing season or only once in a year. Higher shallot bulb yield claims based on TSS field experiments and demonstration farms may be misleading as the actual farm practice shows relatively lower yield. Thus, the profit of adopting TSS for shallot farming will not be as high as reported.

Policy Recommendation

Marketing development of TSS/mini bulb needs farmer's participation as well as shallot traders. TSS or G1 is mainly demanded to produce G2 for consumption. TSS and mini bulb seeds would be essential products that would push the demand for TSS. These farmers would become principal marketing agents through cultivation and distribution.

TSS dissemination will create a new business activity, namely TSS growers, who grow TSS into mini bulbs. However, there should be good market information to link mini bulb supply and its demand as this commodity is bulky and perishable compared to shallot bulb seed, which is more easily transported and has a relatively more extended storage period.

Government support for TSS dissemination is required, such as intensive intensification, market information facilities, easier capital access to farmers, and agricultural insurance as shallot farming is risky. A roadmap for TSS dissemination with specific targets of farmland planted areas for the next several years will be helpful to encourage the Ministry of Agriculture to boost this technology. Without a planned TSS program and specific measures carried out by the Ministry of Agriculture, this commodity will beattractive to researchers for scientific purposes only. TSS is also profitable for the distributors to some extent. However, TSS will have no significant contribution to national shallot production. A new technology, TSS among others, will be adopted by the farmers if it is technically practical, environmentally sustainable, and economically profitable.

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Appendix Table 1. Cost and Benefit Analysis of Shallot Production Field Experiment Adopting TSS in Brebes Regency, Central Java Province, 2008

No.	Item	Unit	Rp/unit	Value (Rp)
A	COST			
1	Seed (TSS)	3.8	1,000,000	3,800,000
2	Labor			1,946,000
3	Input			3,449,700
4	Other inputs			7,815,130
5	Operating labor			17,354,000
6	Materials			42,700,638
7	Other costs			2,356,803
	Total Cost			79,422,271
B	INCOME			
	Gross Income	27.19	3,500,000	95,165,000
	Profit			15,742,729

Source: Basuki (2009)
Note : Density of 100 plants per m^2

Appendix Table 2. Cost and Benefit Analysis of Shallot Production Field Experiment Adopting TSS in Brebes Regency, Central Java Province, 2008

No.	Item	Unit	Rp/unit	Value (Rp)
A	COST			
1	Seed (TSS)	5.7	1,000,000	5,700,000
2	Labor			2,929,000
3	Input			5,196,050
4	Other inputs			11,766,111
5	Operating labor			18,938,000
6	Materials			51,280,969
7	Other costs			2,692,226
	Total Cost			98,502,356
B	INCOME			
	Gross Income	32.96	3,500,000	115,360,000
	Profit			16,857,644

Source: Basuki (2009)
Note : Density of 150 plants per m^2

Appendix Table 3. Cost and Benefit Analysis of A Field Experiment of Shallot Farming Adopting TSS in Bantaeng Regency, South Sulawesi Province, 2017 (per hectare)

No.	Item	TSS Variety			Bulb Seed Variety
		BIMA	TRISULA	TUKTUK	SUPER PHILIPS
A	INPUT COSTS				
1	Inputs	52,735,000	52,735,000	52,735,000	48,185,000
2	Labor	12,850,000	12,850,000	12,850,000	11,500,000
3	Total Cost	65,585,000	65,585,000	65,585,000	59,685,000
B	INCOME				
4	Yield (tons/ha)	7,450	7,030	7,100	5,000
5	Revenue (Rp/ha)	149,000,000	140,600,000	142,000,000	100,000,000
6	Profit (Rp/ha)	83,415,000	75,015,000	76,415,000	40,315,000
7	R/C	2.27	2.14	2.17	1.68

Source: Maintang et al. (2017)

Appendix Table 4. Cost and Benefit Analysis of A Shallot Farming Pilot Project Adopting TSS in Sigi Regency, Central Sulawesi Province, 2017 (per hectare)

No.	Item	Volume (kg)	Unit (Rp/kg)	Value (Rp)
A	INPUT COSTS			
1	Seed			12,000,000
2	Land rent			3,500,000
3	Irrigation			150,000
4	Labor			30,085,000
5	Inorganic fertilizer			2,970,000
6	Organic fertilizer			4,106,000
7	Herbicide			2,250,000
8	Insecticide			14,170,000
9	Opportunity operating capital			1,080,400
	TOTAL COST			70,311,400
B	INCOME			
10	Income	14,900	15,000	223,500,000
11	Profit			153,188,600

Source: Rahayu et al. (2019)

Appendix Table 5. Cost and Benefit Analysis of A Shallot Farming Adopting TSS in Probolinggo Regency, East Java Province, 2015

No.	Item	Value (Rp)	
		0.35 ha	1.0 ha
	INPUT COSTS		
1	Seed (2 kg for 0.35 ha or 5.7 kg for 1.0 ha)	3,000,000	8,571,429
2	Fertilizers	700,000	2,000,000
3	Pesticides	3,000,000	8,571,429
4	Planting wages	600,000	1,714,286
5	labor	8,500,000	24,285,714
6	Net for shed house	2,000,000	5,714,286
7	Total cost of production	17,800,000	50,857,143
	INCOME		
8	Yield (kg)	3,000	8,571
9	Revenue (Rp)	60,000,000	171,428,571
10	Profit (Rp)	42,200,000	120,571,429

Source: PT East West Seed Indonesia (2015)