Smallholder adoption of horticultural crops: the case of dragon fruit in Southeast Sulawesi

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Abstract. Dragon fruit was planted in Indonesia starting in 2000 and has gained popularity since then due to its good taste, high nutrient contents, and many health benefits. The present study aimed to assess the adoption of dragon fruit in South Konawe District of Southeast Sulawesi province. Data collection was done in Pohu to Jaya village in South Konawe District. All dragon fruit growers (30 persons) in the village were taken as respondents. Data were collected through the questionnaire-based interview with the growers and in-depth interviews with agricultural extension officers. Data were analyzed using Cost and Returns analysis and descriptive statistics. Research results showed that dragon fruit production is profitable with high net returns. Farmers perceived several advantages of dragon fruit farming, namely easy to cultivate, shorter time to flowering, harvesting throughout the year, low risk of harvest failure, and reasonable market price. Other farmers were the most important source of information, followed by the social media. Farmers who perceived their skills in dragon fruit cultivation as being good was only 23.3 percent, indicating the importance of improving their knowledge and skills through various means. The local government should provide regular extension services and other supports to improve productivity and sustainability of dragon fruit farming in the district and province as a whole.

1. Introduction

Dragon fruit, *Hylocereus spp*, was originated from America and then spread to subtropical and tropical regions, including Southeast Asia [1]. Called “buah naga” in Indonesia, dragon fruit was planted and developed since 2000. It has gained popularity since then due to its good taste, high nutrient contents, and many health benefits [2]. Dragon fruit can grow well in Indonesia which has diverse agro-climatic conditions. Consumers highly prefer red-fleshed dragon fruit. Red-fleshed dragon fruit is widely cultivated and has a high antioxidant activity [3].

The dragon fruit development in Indonesia takes place quite rapidly and it spreads now to almost all regions. The total cultivated land for dragon fruit production was 8,491 ha, with East Java providing the largest area (68.8 percent), followed by East Kalimantan (17.6 percent) [4]. The farmers’ interest in cultivating dragon fruit is high due to its several advantages, such as early flowering, long productive periods, and being harvestable throughout the year. Besides, its market price is relatively high leading to high net returns.
The cultivated land for dragon fruit production in Southeast Sulawesi province is 30 ha, with productivity being 20-26 ton/ha/year [4]. At present, it is mostly grown exclusively in South Konawe District. Given the land availability and agro-climate suitability, there is great potential for increasing the area under dragon fruit production. At the same time, it is of interest to know the adoption process and what motivates farmers to grow dragon fruit. The present study was undertaken to understand the adoption and present conditions of dragon fruit farming in the study area.

2. Methodology
Due to its status as a newly introduced crop, statistics about dragon fruit are still not recorded yet in the formal sources issued by the Central Bureau of Statistics and relevant departments of agriculture at all government administration levels. The study was undertaken in March 2020 in Potuho Jaya village, Lalembuu subdistrict, South Konawe district, Southeast Sulawesi province. The village was selected as a study area since it has been the main dragon fruit-producing area in the province. There were 30 dragon fruit farmers in the village, and all of them were taken as respondents. Data were collected using an interview method based on the prepared semi-structured questionnaires. Interviews were also done with extension officers in four subdistricts in South Konawe District. Information provided by respondents included associated costs and returns, adoption process, perceived advantages of dragon fruit growing, constraints to production, and perception of trends. The profitability of dragon fruit production was examined using cost and returns analysis [5], [6], while other data were analyzed qualitatively using descriptive statistics.

3. Results and Discussion
3.1 Characteristics of respondents and their farming
All dragon fruit growers were in the age range of 30-60 years old, and the average age of 42.3 years. This average age implies that all respondents were in their productive ages. The majority of respondents (60 percent) had completed senior high school, with an average length of 10.5 years. The number of household members was four persons in average. The average farm size was 0.60 ha. The average age of dragon fruit was 3.8 years. This age of the crop showed that dragon fruit growing was still in the diffusion stage. Dragon fruit growing is the newly introduced profession and has recently been adopted in the study area.

3.2 Introduction and adoption of dragon fruit as a new crop
The availability of information may influence the adoption of new crops, and such information can come from various sources. In the study area, the person who first introduced dragon fruit to the community was a farmer living in the village. He learned dragon fruit cultivation practices when he visited his hometown in Java. Using the planting materials brought from Java, he started growing the crop on his plot in 2012. He promoted dragon fruit to his fellow farmers, but only very few of them decided to grow the new crop. As Nasim et al. [7] has argued, after the introduction of the new crop, there would be some time for it to reach the stage-off stage of diffusion. A newly appointed village head changed the situation. He was interested in the many advantages and benefits of dragon fruit, so in 2015, he decided to make dragon fruit growing as the village administration’ main program. In 2016, farmers started growing dragon fruit and the name of the kampong was even changed to bukit naga or dragon hill.

Significant roles of the early adopter and village administration in the adoption and diffusion of dragon fruit were reflected in the farmers’ responses when asked from which sources they first heard or learned about dragon fruit. The responses were their friends (83.3 percent) and village head (16.7 percent). These two sources provided initial information to the growers, including the level of financial returns, advantages of dragon fruit growing, and cultivation practices. The level of financial returns as one of the primary drivers in the adoption of horticultural crops has also been reported in several studies [8], [9]. Growers might have compared dragon fruit’ relative advantages over the existing crop varieties such as rice, papaya, melon, watermelon, tomato, and short-duration vegetable
crops, and then decided to take them in practice. In this regard, another major reason was that other farmers had adopted it. These findings suggest that copying behavior is essential in the adoption and diffusion of dragon fruit production as reported also in several studies [10], [11].

3.3 Source of information
After adopting the new crop, farmers need sources of information on the production of the crop. In the study village, 66.7 percent of respondents depended on other farmers and 33.3 percent on social media for information on dragon fruit production. The high percentage of farmers who relied on the early-adopter farmer for information was related to the fact that the early-adopter is the pioneer in the dragon fruit production. He successfully grew the crop in his house yard, enabling farmers to observe and develop copying behavior. They learned most cultivation practices from him. Farmers also get cuttings as planting materials from him and benefit from his experience with the variety. Likewise, the use of social media is high because of an increased uptake of social networks fueled by the growing use of smart phones among the villagers. Gathiaka [12] reported that peer effect matters and is mostly positive in smallholder agriculture. According to Vaiknoras [11], smallholder farmers can access the new crop through social networks. Thus farmers had learned from social information networks that could influence their adoption behavior.

None of the respondents mentioned extension agents as a source of information on dragon fruit production. One explanation could be the absence of extension agents who specialized or had experienced in dragon fruit growing. However, the major reason might be that dragon fruit is not the local government’s prioritized crop. The government at all administration levels prioritizes food crops (especially rice), estate crops, and other leading commodities [13]. For the reasons related to inflation, land area, the number of farmers, and the consumption amount, the government also focuses more on such crops as chili, tomatoes, and short duration vegetables. Therefore, most government resources were delivered to these prioritized crops. As a result, dragon fruit farmers were not given due assistance in terms of necessary guidance and training. In other words, the level of extension activities on dragon fruit has been low.

3.4 Perceived advantages of growing dragon fruit
Farmers were asked to give an evaluation of the advantages of growing dragon fruits. All responses were positive. The responses were (i) easy to cultivate, (ii) shorter time to harvesting, (iii) low pest and disease occurrence, (iv) low harvest failure, (v) good market price, and (vi) relatively higher returns. Perceived easy cultivation is related to easier access to locally produced cuttings, easy planting, low labor requirement, and high water-efficiency. From planting to early fruit ripening needs only one year. Growers could get significant fruit production from the crop after 2-3 years, and full production is reached after five years [14], [15]. Farmers cited rats and ants as the major pests, but their overall assessment was that the crop has relatively low pest and disease risk at least up to the present time.

Dragon fruits are still new for people in Southeast Sulawesi, so the market is still increasing. In the last several years, people have started consuming them, and the fruits can be found now in the displays of street retailers in Kendari, the provincial capital. At the same time, the quantities sold for marketing are limited as there are only a few production areas. This situation leads to a reasonable market price for the fruit. Respondents acknowledged that the net returns from dragon fruit production are relatively high given all advantages of the crop.

3.5 Perceived skills in cultivation practices
Dragon fruit has only been cultivated by respondents recently, and none of them have had previous experience in growing the crop before. As a new crop, no agronomic practices have been acquired from the previous cultivation experiences and extension services. The farmer who introduced the crop to the village basically developed his skills through learning by doing approach and then shared them with their fellow farmers. As mentioned previously, farmers also learned cultivation practices from
social media. However, farmers may have to adapt and improve the cultivation methods to overcome the problems encountered in the field.

![Fig. 1. Number of respondents (%) according to their perceived skills in dragon fruit cultivation practices](image)

Given the absence of the traditional or recommended cultivation practices, we could not ask respondents regarding the adoption level of dragon fruit cultivation practices. Instead, respondents were asked to self-assess their knowledge and skills in dragon fruit cultivation practices. As Figure 1 shows, farmers who perceived their skills being “good” were only 23.3 percent, while the remaining being “fair” (53.3 percent) and “poor” (23.3 percent). This result reflected farmers’ lack of knowledge and experiences concerning dragon fruit cultivation practices. The result also revealed the potential to improve such knowledge and skills through various means of extension services, which can have implication for the production and sustainability of dragon fruit farming in the area.

### 3.6 Profitability
Costs consist of fixed and variable costs. Fixed costs include tax and depreciation of farm tools and equipment, such as hoe, machete, scissors, farm cart (gerobak), hand sprayer, and support. Variable costs include the costs of seed, hired labor, fertilizer, and pesticide. Family labor was not included in the cost component.

| No. | Item                          | Rp/farm/year |
|-----|-------------------------------|--------------|
| 1.  | Total Revenue                 | 51,756,000   |
| 2.  | Total Cost                    | 5,316,667    |
| 3.  | Net Returns                   | 46,439,333   |
| 4.  | Net Returns (per ha)          | 77,398,888   |
| 5.  | R-C Ratio                     | 9.37         |

Table 1 presents net returns and the R/C ratio of the third year dragon fruit production. Revenue is Rp51,756,000, which is obtained from the multiplication of the average productivity of 4.54 tons per farm (7.57 ton/ha) and the average farm price of Rp11,400 per kg. This productivity is less than that reported by Khairiyakh, Irham and Mulyo [16], but is approximately the same as Dewi and Ustriana [17] had reported. The net returns are higher than that of maize [18], key lime [19], rice [20], pepper [21], and patchouli [22], but less than that of melon and watermelon [9]. The net returns will follow the productivity, which can increase up to the 10th year of the crop age. The R/C ratio of 9.37 shows that dragon fruit growing is profitable as Rp1,000 spent in the farming yields revenue of Rp9,370.

### 3.7. Constraints
Dragon fruit production currently faces several constraints. The limited availability of improved planting materials was mentioned as the major constraint facing dragon fruit management practices.
At present, the planting materials were obtained from the early adopter, which was perceived as the only reliable source given the lack of seed breeders in the province. However, the varieties were not clear and were only distinguished from the flesh color. So the main issue is the availability of parent seed with clear origin, which is actually the area of the local government to provide. Greater availability of superior planting materials would facilitate increased production.

Pest occurrence is another constraint to dragon fruit production. Ants can cause significant damage to the plants, flowers, and fruits. Respondents also reported rodent attack, which eats up ripe fruit and leaves only the outer shell as has been found in Yogyakarta [23]. However, some diseases that attacked dragon fruit plants in West Sumatera [24] and Bali [2] were not reported yet in the village.

Water shortage during the dry season was reported as a constraint in dragon fruit growing. Despite being well-known for its high water-use efficiency [25], intense sunlight and too high temperature are not suitable for dragon fruit [26]. Some farmers addressed the issue by watering the crop twice a week.

4. Conclusion

The study sought to understand the adoption and the present condition of dragon fruit farming among growers in South Konawe district of Southeast Sulawesi province. Research results showed that dragon fruit production is profitable with net returns higher than that of many other crops. Dragon fruit was introduced by a farmer who gained knowledge and skills from his friends in Java. Farmers perceived several advantages of dragon fruit farming, namely easy to cultivate, shorter time to flowering, harvesting throughout the year, low risk of harvest failure, and good market price. Other farmers were the most important source of information, followed by social media. Farmers who perceived their skills in dragon fruit cultivation as being good were only 23.3 percent, indicating the importance of improving their knowledge and skills through various means. The local government should provide formal extension services and other supports to help expand dragon fruit production to other areas, and to improve the productivity and sustainability of dragon fruit farming in the province.

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