# The production of honey and pot-pollen from stingless bee Tetragonula sp. and their contribution to increase the farmers income in West Lombok, Indonesia

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# The production of honey and pot-pollen from stingless bee *Tetragonula* sp. and their contribution to increase the farmers income in West Lombok, Indonesia

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## Abstract

Beekeeping in stingless bees is called meliponiculture and the products produced consist of honey, bee bread, and propolis. However, in West Lombok, Indonesia there is lack of information about the contribution of honey and bee bread sold on the beekeepers or farmers income. Therefore, the aims of this study were to determine the production of honey and bee bread from the stingless bee *Tetragonula* sp. and their contribution to increase the farmer's income. In this study was used 112 colonies of stingless bee *Tetragonula* sp. were moved from the bamboo hives to the box hives. All colonies were meliponiculture for about 8 months in the yard and rice field and harvested in two periods namely the first was after four months of meliponiculture and the second was four months after the first harvested. The recent findings showed that the production of honey in the yard was ranging 153.2 to 164.2 ml/hive/4 months and in the rice field was ranging 153.2 to 160.5 ml/hive/4 months. The production of bee bread in the yard was ranging 43.3 to 47.6 g/hive/4 months and in the rice field was ranging 43.5 to 44.1 g/hive/4 months. The total production of honey in the yard was 17,776 ml/8 months/56 colonies and in the rice field was 17,556 ml/8 months/56 colonies. The total production of bee bread in the yard was 5,093 g/8 months/56 colonies and in the rice field was 4,903 g/8 months/56 colonies. The contribution total of honey and bee bread on the farmers income in the yard was IDR 7,240,200 and in the rice field was IDR 7,128,700. It can be concluded that the yard and rice field can be used as the location for meliponiculture of stingless bee *Tetragonula* sp. to increase the farmer's income based on the products of honey and bee bread.

***Keywords:*** *bamboo hives, box hives, meliponiculture, nectar, pollen*

## Introduction

Stingless bee species in the world for about 500 species have been identified and maybe more than 100 species has not been studied (Michener 2013). Furthermore, in Indonesia is found a minimum 46 species (*tribe Meliponini*) from genus *Austroplebeia* Moure, *Geniotrigona* Moure, *Heterotrigona* Schwarz, *Homotrigona* Moure, *Lepidotrigona* Schwarz, *Lisotrigona* Moure, *Papuatrigona* Michener and Sakagami, *Pariotrigona* Moure, *Tetragonula* Moure, and *Wallacetrigona* Engel and Rasmussen (Kahono et al 2018). For example in several region in Indonesia have been reported 7 stingless bee species (*Tetragonula laeviceps*, *T. iridipennis, T. biroi, T. sapiens, T. sarawakensis*, *Lepidotrigona terminata*, and *Heterotrigona itama*) from Yogyakarta (Trianto and Purwanto 2020), 6 species (*T. laeviceps, T.* cf. *biroi*, *T. drescheri*, *T. sarawakensis*, *H. itama,* and *L. terminata*) from the industry meliponiculture in West Java Province (Purwanto and Trianto 2021), 5 species (*T. sapiens, T. fuscobalteata, T. clypearis, L.*

*terminata,* and *Wallacetrigona incisa*) from West and South Sulawesi (Sayusti et al 2020), and 3 species (*Tetragonula laeviceps*, *T. aff. fuscobalteata*, and *Heterotrigona itama*) from Belitung (Azizi et al 2020).

In Indonesia, stingless bees are created nesting as their habitats are found in the bamboo, sugar palm stalks, tree trunks or wood, in the ground and in the house wall which are producing honey, bee bread, and propolis (Agus et al 2021, 2019; Agussalim et al 2019, 2019a, 2020, 2021; Erwan et al 2020, 2021; Sabir et al 2021; Supeno et al 2021). The production of honey and propolis from *Tetragonula* sp. which is meliponiculture in North Lombok, Indonesia have been studied (Agussalim et al 2015; Erwan et al 2020, 2021), *T. laeviceps* in Yogyakarta (Agussalim et al 2020), and *T. laeviceps* in West Java (Abduh et al 2020). However, honey and propolis production from stingless bee *Tetragonula* sp. in West Lombok (Indonesia) has not been studied. The contribution of meliponiculture stingless bee species by the sold of their products can be increase the beekeepers income have studied in several country (Abd Razak et al 2016; Aguilar et al 2013; Alves 2013; Ayala et al 2013; Fuenmayor et al 2013; Halcroft et al 2013; Mustafa et al 2018). However, in West Lombok, Indonesia there is lack of information about the contribution of honey and bee bread on the beekeepers or farmers income. Therefore, the aims of this study were to determine the production of honey and bee bread from the stingless bee *Tetragonula* sp. and their contribution to increase the farmer's income.

## Materials and Methods

### Colony transfer and meliponiculture of stingless bee *Tetragonula* sp.

This study was conducted in Lembah Sari Village, Batu Layar Sub-district, West Lombok District, Indonesia. The stingless bee *Tetragonula* sp. as much 112 colonies were obtained around the Lembah Sari Village from the bamboo as their natural habitat. The colony transfer from the bamboo to box hives was performed in the night to avoid stress from the bees according to previous methods (Agussalim 2020; Agussalim et al 2020; Erwan et al 2020, 2021). Briefly, the colonies from the bamboo hive were split by using a machete and all the brood cells were moved to box hives, followed by the bee workers, drones, and queen bee. Furthermore, the box hives entrance was smeared by the propolis from the entrance of the bamboo hives to make it easier for the workers or foragers to identify their new hive from box hives. Finally, the box hives were placed in bee houses (Photo 1) with the entrance directly to the feed sources, namely nectar and pollen.

**Photo 1.** The bee houses were used to meliponiculture of stingless bee *Tetragonula* sp. in the yard (left) and rice field (right)

**Photo 2.** Honey inside the red circle, bee bread inside the yellow circle (left) and brood cells (right) of stingless bee *Tetragonula* sp.

The 112 colonies of *Tetragonula* sp. from the box hives were meliponiculture in the yard and rice field, each 56 colonies (replications) per location. The plant types as the nectar and pollen sources were identified around the bee houses (size 2 × 1.5 × 2.5 meters) which were shown in Photo 1 at a maximum distance of 300 meters. In addition, in front of the box hives were hung of sugar palm pollen to support the protein source and the box hives were used in this study have a size 30 × 20 × 17 cm.

**Brood cells number**

The brood cells number was described the health condition and development of the stingless bee colonies. The box hives were opened and then brood cells (Photo 2 right) were taken from 112 colonies. Afterwards, the brood cells number were counted for all brood cells by using a hand counter check.

**Honey and bee bread production**

Production of honey and bee bread were measured after meliponiculture 4 months for the first harvest and the second harvest after meliponiculture 4 months after the first harvest. Briefly, honey and bee bread of the *Tetragonula* sp. were harvested from the box hives by cutting the honey and bee bread pots and were put in the plastic glass. Afterward, the honey was squeezed to separate honey and propolis, then the clean honey volume was measured by using a measuring cylinder (Agussalim et al 2020). Bee bread was separated from propolis by taking the bee bread directly to separate propolis and bee bread, then the clean bee bread was measured by using a digital scale.

**Farmer's income**

Farmer's income was calculated from the honey and bee bread productions which were multiplied by the price of honey and bee bread. The farmer's income was compared among the location from yard and rice field to determine the higher of income can be obtained by the beekeepers or farmers.

**Analysis data**

All data of production of honey and bee bread, brood cells number, and farmers' income were analyzed by an independent T-test by using SPSS software (Windows version of SPSS, release 23).

**Results and Discussion**

**Honey production**

The research finding showed that the production of honey from stingless bee *Tetragonula* sp. in the yard and rice field for the first and second harvest did not differ. The honey production in the yard for the first harvest was 164.2 ml/hive/4 months and in the rice field was 160.5 ml/hive/4 months. Furthermore, the honey production in the yard and rice field was similar for the second harvest was 153.2 ml/hive/4 months (Table 1). The honey production from stingless bee *Tetragonula* sp. was supported by the plant types as the nectar source in the yard such as mango, coconut, sugar palm sap, starfruit, beans, rambutan, and water apple, while in the rice field consists of chili, eggplant, and long beans. Coconut, rambutan, mango, and starfruit are potential nectar source for honeybee (Agussalim et al 2017, 2018). The honey production among the yard and rice field was similar may be caused by their distance being 400 meters, so *Tetragonula* sp. can collect nectar from plant flowers in front of their hives and the other location (yard and rice field). This study was supported by Eltz et al (2002) and Nunes-Silva et al (2010) were reported that the stingless bee can be within reach of plant flowers to collect nectar or pollen up to a distance of 600 to 1,000 meters.

**Table 1.** The average of honey production from stingless bee *Tetragonula* sp. were meliponiculure in the yard and rice field

| Honey production | Meliponiculture locations | | SEM | *p* |
|---|---|---|---|---|
| | Yard | Rice field | | |
| First harvest (ml/hive/4 months) | 164.2 | 160.5 | 4.14 | 0.654 |
| Second harvest (ml/hive/4 months) | 153.2 | 153.2 | 3.60 | 0.998 |

The average of honey production from stingless bee *Tetragonula* sp. in our study was ranging from 153.2 to 164.2 ml/hive/4 months of the meliponiculture was differ to reported by Agussalim et al (2020) from the *Tetragonula laeviceps* ranging from 60 to 263 ml/4 months of meliponiculture with the plant types as the nectar source consist of calliandra, bananas, mangoes, chicory, tamarind, sunflowers, indigofera, catappa, syzygium, kapok, alfalfa, starfruit, matoa, water apple, bilimbi, lemon, guava, chili, caimito, canarium, and rambutan. Supeno et al (2021) reported the honey production from stingless *Tetragonula* sp. was meliponiculture in coffee plantations as the main nectar source was 5.74 g/hive/5 months. Furthermore, Erwan et al (2020) was also reported that the production of honey from *Tetragonula* sp. which was meliponiculture by using a box hive was 18.72 ml/1 month and in bamboo hive was 9.18 ml/1 month with the plant types as the nectar source consist of banana, longan, cashew, mango, starfruit, sunflowers, coconut, bilimbi, Jamaica cherry, calliandra, cassava, and papaya. Honey production was affected by the availability of nectar from plants, temperature, humidity, worker population, the activity level of the foragers (Agussalim et al 2020; Erwan et al 2020), and the brood cells number. However, the brood cells number in the yard was lower than in the rice field in the first four months, but in the second four months, the brood cells number in the yard was higher than in the rice field (Table 3). The brood cells were

hatches that became the workers or drones which had an impact on the increase of the bee population.

**Bee bread production**

Pollen collected by the foragers is stored in the hive or pot as a bee bread, where pollen is mixed by honey and bee secretion, then fermented by a lactic acid to preserve it (Bogdanov 2017). The research findings showed that the bee bread production in the yard and rice field for the first and second harvest was similar. The production of bee bread in the yard for the first harvest was 43.3 g/hive/4 months and in the rice field was 43.5 g/hive/4 months. Furthermore, the production of bee bread in the yard for the second harvest was 47.6 g/hive/4 months and in the rice field was 44.1 g/hive/4 months (Table 2).

**Table 2.** The average of bee bread production from stingless bee *Tetragonula* sp. were meliponiculure in yard and rice field

| Bee bread production | Meliponiculture locations | | SEM | *p* |
|---|---|---|---|---|
| | Yard | Rice field | | |
| First harvest (g/hive/4 months) | 43.3 | 43.5 | 1.52 | 0.967 |
| Second harvest (g/hive/4 months) | 47.6 | 44.1 | 1.58 | 0.269 |

The bee bread production of *Tetragonula* sp. was supported by the plant types as the pollen source in the yard consists of sugar palm, coconut, beans, and water apple, while in the rice field such as paddy, maize, chili, eggplant, and long beans. Coconut and maize are potential pollen sources for honeybees (Agus et al 2019; Agussalim et al 2017, 2018). The distance of the bee house in the yard and rice field was 400 meters which was impact on the foragers from *Tetragonula* sp. can also collect pollen from the yard and rice field. This finding was supported by Eltz et al (2002) and Nunes-Silva et al 2010) were reported that the stingless bee foragers can be within reach of the plant flowers to collect nectar and pollen up to a distance of 600 to 1,000 meters. The average of bee bread production in our study was ranging from 43.3 to 47.6 g/4 months/colony was differ to reported by Agus et al (2019) that the bee bread production of stingless bee *T. laeviceps* was ranging from 1.02 to 4.56 g/2 months of the meliponiculture with coconut, banana, spinach, Mexican creeper, acacia, paddy, pomelo, maize, and stink beans as the pollen sources. Production of bee bread was affected by the availability of pollen from plant flowers, the population of foragers, the activity of the foragers to collect pollen, and the environmental condition (temperature, humidity, and season). In addition, also was affected by the brood cells number which were impacted on the increase of the bee population.

**Brood cells number**

The research finding the different location for meliponiculture was highly significant on the brood cells number of stingless bee *Tetragonula* sp. ($p<0.01$). The brood cells number of stingless bee *Tetragonula* sp. which was meliponiculture in the yard was 2,731 cells/hive/4 months was lower than brood cells number in the rice field was 3,112 cells/hive/4 months for the first four months. Furthermore, the brood cells number in the yard was 3,121 cells/hive/4 months was higher than brood cells number in the rice field was 2,739 cells/hive/4 months for second four months (Table 3). The brood cells are hatches that become the workers when the eggs were fertilized and unfertilized eggs were hatches become the drones. The brood cells number was affected by the availability of pollen from plant flowers as the raw material to

produce royal jelly as the queen bee feed. Thus, was impacted on the productivity of the queen bee to produce more eggs as the candidate of workers, drones, and candidate of queen bee (Jarau et al 2009; Sakagami 1982).

**Table 3.** The brood cells number of stingless bee *Tetragonula* sp. were meliponiculure in the yard and rice field

| Brood cells number | Meliponiculture locations | | SEM | *p* |
|---|---|---|---|---|
| | Yard | Rice field | | |
| First four months (cells/hive/4 months) | 2,731[b] | 3,112[a] | 69.3 | 0.005 |
| Second four months (cells/hive/4 months) | 3,121[a] | 2,739[b] | 66.7 | 0.004 |

[a,b] *Different superscripts within rows indicate differences at p<0.01*

**Farmer's income**

The research findings showed that the total of honey production from stingless bee *Tetragonula* sp. in the yard was 17,776 ml/8 months and in the rice field was 17,556 ml/8 months were obtained from 56 colonies. Furthermore, the total of bee bread production of stingless bee *Tetragonula* sp. in the yard was 5,093 g/8 months and in the rice field was 4,903 g/8 months were obtained from 56 colonies (Table 4). Honey and bee bread are usually sold by the beekeepers when they are harvested in small and large quantities. In our study, the total production of honey from stingless bee *Tetragonula* sp. was contributed to the farmers' income of IDR 6,221,600 from the yard and in the rice field was IDR 6,148,100. In addition, the bee bread production also was contributed to the farmers' income of IDR 1,018,600 in the yard and in the rice field of IDR 980,600 from 8 months of meliponiculture. The total of farmers' income from honey and bee bread was IDR 7,240,200 from the yard and IDR 7,128,700 from the rice field as the location of meliponiculture. Alves (2013) reported that Rio Grande do Norte-Paulo Menezes is one of the largest suppliers of honey from stingless bees to supermarkets and is sold at BR$ 60.00 per gallon compared to honey from *A. mellifera* which is BR$ 5.00 per gallon. Furthermore, in 2004, Menezes produced 300 liters of honey and was sold to supermarkets with an income of BR$ 18,000 per year or BR$ 1,500 per month.

Our study indicates that the meliponiculture of stingless bee *Tetragonula* sp. to produce honey and bee bread can be contributed to increase the farmers income, especially the farmers in the rice field. In the rice field, the stingless bee *Tetragonula* sp. can play a role as the pollinator agent of several plants which are planted by the farmers to increase the productivity of agricultural plants. Partap (2011) explained that the cross pollination which is involved the honeybees or stingless bees as the pollinator agent can lead to increased agricultural productivity, environment conservation and maintenance of biodiversity, improvement of the soil conservative and soil fertility. Thus, which had an impact on the increased farmers income and food security and improved livelihoods.

**Table 4.** The total production of honey and bee bread and their contribution to farmers income were meliponiculure in the yard and rice field

| Parameters | Meliponiculture locations | |
|---|---|---|
| | Yard | Rice field |
| Total production of honey (ml/8 months/56 colonies) | 17,776 | 17,556 |
| Total production of bee bread (g/8 months/56 colonies) | 5,093 | 4,903 |
| Farmers income from honey (IDR, price was 350/ml) | 6,221,600 | 6,148,100 |
| Farmers income from bee bread (IDR, price was 200/g) | 1,018,600 | 980,600 |
| Total farmers income from honey and bee bread (IDR) | 7,240,200 | 7,128,700 |

Currently, the meliponiculture of the stingless bee species in West Lombok and North Lombok has been practiced by the communities generally as an additional income and beekeepers as the main income. Abd Razak et al (2016) reported that the meliponiculture of stingless bees can be used as an additional income for the rubber smallholders in Malaysia, because the rubber is the nectar extrafloral source for stingless bees as the raw material to produce honey. Mustafa et al (2018) explained that several stingless bee products like honey and propolis have helped promote the beekeepers as entrepreneurs and provided an additional income for the community, where they contributed an additional income of RM 833 for honey and RM 1,666 for propolis. However, the beekeepers in West Lombok and North Lombok have not yet sold propolis and maybe in the future as an additional income when propolis is sold. Generally, the meliponiculture of stingless bees can increase the farmers or beekeepers income by the sold of honey, bee bread, and propolis (Abd Razak et al 2016; Aguilar et al 2013; Alves 2013; Ayala et al 2013; Fuenmayor et al 2013; Halcroft et al 2013; Mustafa et al 2018).

## Conclusions

- Production of honey from the stingless bee *Tetragonula* sp. which was meliponiculture in the yard and rice field for the first and second harvest ranging 153.2 to 164.2 ml/hive/4 months and bee bread ranging 43.3 to 47.6 g/hive/4 months.
- The brood cells number from the stingless bee *Tetragonula* sp. which was meliponiculture in the yard and rice field ranging 2,731 to 3,121 cells/hive/4 months.
- The total contribution of honey and bee bread sold on farmers' income was IDR 7,240,200 in the yard and IDR 7,128,700 from 56 colonies in the rice field.
- The yard and rice field can be used as the location for meliponiculture of stingless bee *Tetragonula* sp. to increase the farmer's income and improve livelihoods.

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