

PAPER • OPEN ACCESS

Farmers' perception to climate change and adaptation to sustain black pepper production in North Lampung, Indonesia

To cite this article: R Evizal and F E Prasmatiwi 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **739** 012019

View the [article online](#) for updates and enhancements.

Farmers' perception to climate change and adaptation to sustain black pepper production in North Lampung, Indonesia

R Evizal¹ and F E Prasmatiwi¹

¹Faculty of Agriculture, University of Lampung, Bandar Lampung, Indonesia

E-mail: rusdi.evizal@fp.unila.ac.id

Abstract. Lampung Province is the largest black pepper production area in Indonesia mainly in North Lampung District. However, in the last decade the area and production is declining. This research aims to study farmers' perceptions of climate change and challenge to sustain black pepper production in North Lampung. The study was carried out in North Lampung District using survey method at two sub-districts of major producing area of black pepper that purposively sampled namely Abung Barat and Abung Tengah sub-district in March-June 2019. A total of 93 respondent farmers from 4 villages were randomly sampled. The conclusions are: (1) Sustainability of black pepper production in North Lampung faces challenges regarding declining of planting areal, low productivity, climate change, and low interest of the younger generation in black pepper farming; (2) Farmers in the two sub-districts mostly agree that the current climate is different from the climate 10 years ago and they have perception that as impact of climate change pepper yield is decreased by 25-49%; (3) To sustain black pepper production and to adapt climate change, farmers are practicing mixed culture system of pepper-coffee-and other cash crops, using live support of legume tree, and continuing rehabilitation or replanting of black pepper plantation

1. Introduction

Lampung Province is the largest black pepper production area in Indonesia which produces 14,510 tons of black pepper and contributes 16.65% of Indonesia's pepper production. Meanwhile North Lampung Regency is the centre of pepper cultivation in Lampung with an area in 2018 of 11,714 ha, production of 3,525 tons, productivity of 402 kg/ha and the number of farmers is 16,743 farmers [1].

The area of pepper plantations in Lampung has decreased from 61,982 ha in 2013 to 45,883 ha in 2018, partly due to an increase in the incidence of extreme weather, both long drought and high rain intensity due to climate change. Extreme weather can cause plants to die from drought or die from disease [2]. If pepper replanting is unsuccessful, on the support trees, farmers plant Java long pepper [3]. The area of black pepper plantations in Lampung Province has recently tended to decrease, perhaps due to inappropriate environmental conditions. Rainfall intensity is the most important factor affecting pepper productivity [4].

Another problem in pepper farming in Lampung is the low yield. Farmers manage pepper gardens less intensively especially when prices are low, among others, related to fertilization, land conservation, and pest management that caused low plant population [5]. Black pepper plants require an adequate supply of nutrients, especially during the development of fruits. To maintain optimal growth and yield, adequate amounts of macro and micro nutrients are needed [6]. Nutrients availability at the time of floral primordial initiation caused alternate bearing of pepper. There are



indications that efficient utilization of metabolites and nutrients to bear fruit in current year may result in weak growth and low yield in the subsequent year [7].

High pepper production is obtained in new planting of pepper plantations from forests where the content of organic matter is high. After 2-3 years of harvest or 6-7 years old pepper, production will fall due to decreased land fertility and increased tree mortality due to pests and diseases [8]. Nowadays forest land is not available for farmers in Lampung to clear for new planting. Lampung farmers practice ethno-agronomy of permanent pepper plantations of using live trees support, mixed cropping and less intensive management. This less intensive system is also shown by routine annual replanting, non-uniform plant age, and productive plants of only 60-70%. After 20-30 years, farmers continue to do intercropping and practicing agroforestry system based on coffee plant. Following another practicing, farmers clear the land to plant annual food crops and start a new cropping system cycle [9], [10].

Based on time series analysis of rainfall, it indicated that regional climate system is influencing the local rainfall in Lampung as the global warming impact [11]. Then it would affect rainfall distribution and agriculture production in Lampung [12]. Climatic variable such as rainfall intensity and air temperature have relationship on production and productivity of black pepper [13]. Prolong dry season has negative effect on black pepper plants that reduce the yield [14]. This research aims to study farmers' perceptions of climate change and challenge to sustain production of black pepper in North Lampung.

2. Material and Method

The study was carried out in March-June 2019 at North Lampung District using survey method. Two sub-districts of major producing area of black pepper were purposively sampled namely Abung Barat and Abung Tengah sub-district (see Figure 1). From each sub-district, two villages were purposively sampled. Primary data was collected from a total of 93 respondent farmers were randomly sampled. Secondary data was obtained from Central Bureau of Statistics of Lampung. Data analysis used descriptive methods.

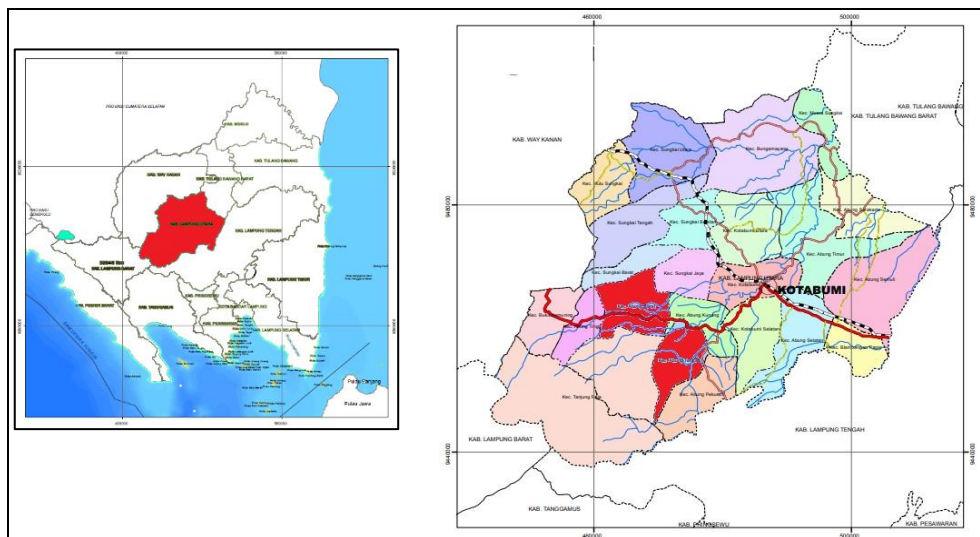


Figure 1. Location site of study

3. Results and Discussion

3.1. Pepper area declining

In period 2003-2016, the area of pepper cultivation in Sub-district of Abung Barat and Abung Tengah decreased dramatically by 80% and 74%, respectively (Figure 2). In total District of North Lampung, there was a 51% reduction in area, from 23,871 ha to 11,714 ha. Black pepper production from

District of North Lampung fell 60% from 9,564 tons to 3,772 tons. This figure raises questions regarding the sustainability of pepper farming and production in North Lampung as the major producer of black pepper in Lampung Province.

When we travel from West to East in this region, it is rare to find pepper plantation that grow well. The decline in the area of pepper cultivation in the two sample sub-districts can illustrate that the transformation of pepper plantation into another land use such as cassava field is occurring especially along the road and around settlement. Pepper plantations shift to more remote area and to neighbour district such as Way Kanan and Tanggamus as emerging major production area as reported by Karmawati et al [5].

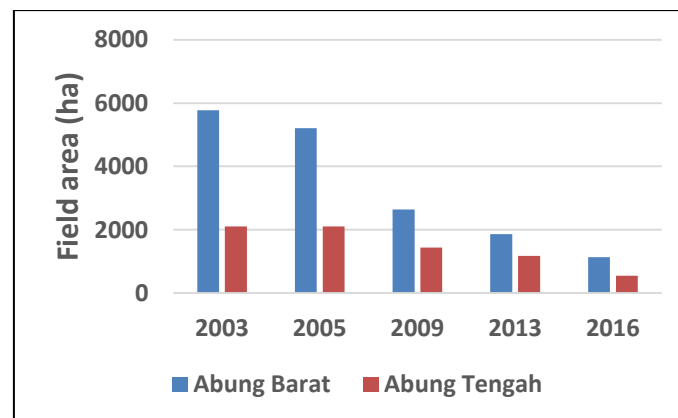


Figure 2. Decline of pepper field area

3.2. Farmers' characteristics

The sample farmers who manage pepper farming are generally elderly. In Abung Barat 55.5% of the farmers are 50 years old or more. Likewise, in Abung Tengah, as many as 60% of the farmers are 50 years old or more. In the two sub-districts most farmers (46%) are 50-59 years old (Table 1). This situation can affect the yield and sustainability of pepper production in this region.

Table 1. Respondent farmer's characteristic

| Respondent characteristic | Class | Farmers (%) | |
|----------------------------------|---------|-------------|--------------|
| | | Abung Barat | Abung Tengah |
| Farmers' age (year) | 30-39 | 4.8 | 16.7 |
| | 40-49 | 39.7 | 23.3 |
| | 50-59 | 46.0 | 46.7 |
| | 60-69 | 9.5 | 10.0 |
| | 70-79 | 0 | 3.3 |
| Land tenure of black pepper (ha) | <1 | 0 | 3.3 |
| | 1-1.9 | 69.8 | 63.3 |
| | 2-2.9 | 20.6 | 23.3 |
| | 3-3.9 | 8.0 | 0.0 |
| | >=4 | 1.6 | 10.0 |
| | Average | 1.47 | 1.71 |

The pepper land ownership of the sample farmers is relatively small, which is less than 2 ha. As many as 69.8% of farmers in Abung Barat have pepper land less than 2 ha and the average is 1.47 ha. In Abung Tengah, 63.3% of farmers own land area of 1-1.9 ha and 3.3% of farmers own land less than 1 ha and the average is 1.71 ha. As much as 93-97% of farmers own land from the inheritance of their parents. The area of pepper land ownership in this area is similar to North Lampung as reported by Asnawi et al [15] and also similar to that in District Way Kanan as reported by Togatorop et al [16].

3.3. Yield of black pepper

Productivity of black pepper plantation in period 2016-2019 in Abung Barat and Abung Tengah is not significantly different (Figure 3). In the two sub-districts, the productivity of pepper plantations is relatively low, ranging from 140-344 kg/ha/year. In Abung Barat, the average productivity of pepper plantations in 2016-2019 was 181, 141, 181, and 259 kg/ha/year, respectively. Meanwhile in Abung Tengah the average productivity was 291, 183, 274, and 344 kg/ha/year. This means that the pepper yield per tree is only 1-2 ounces if the pepper plant population (stand per hectare) is 1600 trees/ha.

This yield is lower than those of black pepper plantation as a whole in North Lampung District in 2018, which is around 402 kg/ha/year. Due to the area of pepper cultivation in North Lampung is the largest in Lampung, namely 8,772 ha, the pepper production from North Lampung District is the highest among other districts, reaching 3,525 tons/year of dry bean [1]. However, the productivity figure is similar to the report of Asnawi et al [15] where the productivity of pepper plantations in North Lampung is 285 kg/ha.

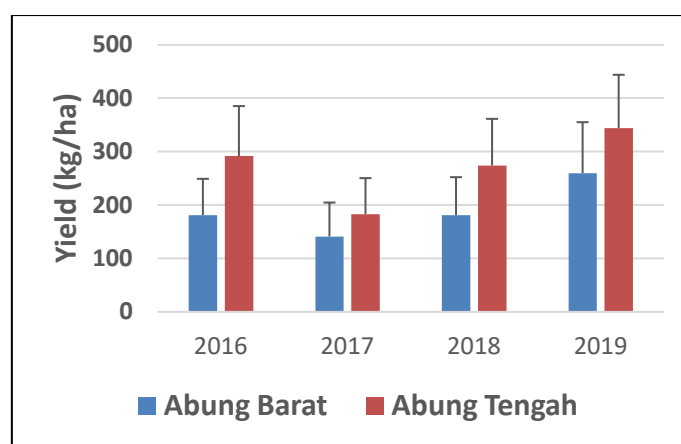


Figure 3. Yield of black pepper plantation in 2016-2019

3.4. Climate change impact

Farmers in the two sub-districts mostly agree that the current climate is different from the climate 10 years ago. There were 82.8% of farmers who agreed and 17.2% of farmers who disagreed. Farmers' perceptions regarding climate change indicators are presented in Table 2. Most farmers agree that in the last 10 years rainfall has increased (78.5% farmers agreed), air temperature has increased (61.3% farmers agreed), drought season has become longer (51.6% farmers agreed), rainy season has become shorter (68.8% farmers agreed) and soil moisture has decreased (98.9% farmers agreed). Most farmers (57% farmers) less agree that in the last 10 years wind speed has increased, meanwhile 20.4% farmers agreed and 22.6% farmers disagreed.

Table 2. Farmers' perception on climate change indicators

| Perception | Agree (%) | Less agree (%) | Not agree (%) |
|-------------------------------|-----------|----------------|---------------|
| Rainfall intensity increasing | 78.5 | 12.9 | 8.6 |
| Air temperature increasing | 61.3 | 33.3 | 5.4 |
| Wind speed increasing | 20.4 | 57.0 | 22.6 |
| Extreme weather increasing | 26.9 | 21.5 | 51.6 |
| Longer drought season | 51.6 | 31.2 | 17.2 |
| Shorter rainy season | 68.8 | 29.0 | 2.2 |
| Soil moisture decreasing | 98.9 | 1.1 | 0 |

Climate change might have impact on black pepper farming. Farmers' perceptions regarding climate change impact on black pepper farming are presented in Table 3. Most farmers agree that climate change (extreme weather) is causing peppercorn less weight (88.2% farmers agreed), light

peppercorn is increased (65.6% farmers agreed), branch dieback is increased (61.3% farmers agreed), plant death is increased (79.6% farmers agreed), disease incidence is increased (62.4% farmers agreed), pest incidence is increased (61.3% farmers agreed), yield of pepper is decreased (76.3% farmers agreed), pepper yield is highly fluctuating (100% farmers agreed), and risk of pepper farming is increased (87.1% farmers agreed).

Table 3. Farmers' perception on climate change impact

| Impact of climate change on black pepper farming | Agree (%) | Less agree (%) | Not agree (%) |
|--|-----------|----------------|---------------|
| Flowers rotting/drying | 30.1 | 69.9 | 0 |
| Young fruits rotting/drying | 32.3 | 67.7 | 0 |
| Less weight of peppercorn | 88.2 | 9.7 | 2.1 |
| Increased light peppercorn | 65.6 | 34.4 | 0 |
| Increased branch dieback | 61.3 | 28.0 | 10.7 |
| Increased plant death | 79.6 | 20.4 | 0 |
| Increased disease incidence | 62.4 | 29.0 | 8.6 |
| Increased pest incidence | 61.3 | 30.1 | 8.6 |
| Decreased yield of black pepper | 76.3 | 23.7 | 0 |
| Black pepper yield highly fluctuating | 100 | 0 | 0 |
| Crop failure | 22.6 | 24.7 | 52.7 |
| Increased farming risk | 87.1 | 11.8 | 1.1 |

Most of farmers in Abung Barat (50.8% farmers) and Abung Tengah (56.6% farmers) have perception that as impact of climate change pepper yield is decreased by 25-49%. However, most farmers are still consistent with black pepper farming. As many as 88.9% of pepper farmers in Abung Barat and 86.7% of pepper farmers in Abung Tengah said they would not replace pepper plants with other crops. Besides climate change, the challenge to sustain production of black pepper in the region is the low interest of the younger generation in black pepper farming. No youth is interested in black pepper farming and many of them is less interested or not interested (Table 4).

Table 4. Factors to sustain black pepper production

| Sustainability Factors | Perception | Abung Barat | Abung Tengah |
|--|-----------------|-------------|--------------|
| Yield decreasing as impact of climate change | <25% | 41.3 | 26.7 |
| | 25-49% | 50.8 | 56.6 |
| | 50-75% | 7.9 | 16.6 |
| To change to other commodity | Yes | 11.1 | 13.3 |
| | No | 88.9 | 86.7 |
| Youth interest to black pepper farming | Interested | 0 | 0 |
| | Less interested | 63.5 | 46.7 |
| | Not interested | 36.5 | 53.3 |

3.5. Agronomic practicing to sustain production

Farmers in North Lampung have practiced local wisdom to adapt climate change in black pepper farming as presented at Table 5. They cultivate pepper using live support trees of *Gliricidia sepium*, an important legume tree that improve soil fertility due to its legume nodulating bacteria [17]. Farmers practice mixed culture system of black pepper, coffee and *Pithecellobium jiringa*, another legume tree that produces high price fruits. Farmers cultivate high yielding variety so called Kerinci variety that adapted to local agro-climate. Another practice is continuous rehabilitation or replanting the death pepper vine mainly caused by drought and basal rot disease. If this work is successful, then pepper plantation can last until the age of more than 20 years and even reaches the age of 40 years as reported by Evizal [9] and Asnawi et al [15]. Maintaining land covered by soft weed is also important to prevent erosion and basal rot disease spreading [18].

Table 5. Ethno-agronomy practicing to adapt climate change

| No | Agronomic practicing to adapt climate change | Abung Barat (% farmers) | Abung Tengah (% farmers) |
|----|---|--|--|
| 1. | Cropping system | Mixed culture (95.7%), monoculture (4.3%) | Mixed culture (96.7%), monoculture (3.3%) |
| 2. | Intercrop for cash crop diversification | Robusta coffee (313.3 plant/ha), <i>Pithecellobium jiringa</i> (9.4 plant/ha) | Robusta coffee (424.7 plant/ha), <i>Pithecellobium jiringa</i> (10.2 plant/ha) |
| 3. | Using live support for pepper climbing | <i>Gliricidia sepium</i> (100%), pruned 1 x per year | <i>Gliricidia sepium</i> (100%), pruned 1-2 x per year |
| 4. | Replant using 2-3 pepper cuttings per support tree | Yes (81%), No (19%) | Yes (100%) |
| 5. | High yielding variety adapted to local agro-climate | Var. Kerinci (100%) | Var. Kerinci (100%) |
| 6. | Soil cover management | No hand weeding (84%), with hand weeding (16%). Spraying herbicide 1-3x per year | No hand weeding (80%), with hand weeding (20%). Spraying herbicide 1-3x per year |
| 7. | Continuing rehabilitation or replanting | Age of plantation 22.4 years | Age of plantation 21.9 years |

4. Conclusions

This study concluded that:

- (1) Sustainability of black pepper production in North Lampung faces challenges regarding declining of planting areal, low productivity, climate change, and low interest of the young generation in black pepper farming.
- (2) Farmers in the two sub-districts mostly agree that the current climate is different from the climate 10 years ago and they have perception that as impact of climate change pepper yield is decreased by 25-49%.
- (3) To sustain black pepper production and to adapt climate change, farmers are practicing mixed culture system of pepper-coffee-and other cash crops, using live support of legume tree, and continuing rehabilitation or replanting of black pepper plantation.

References

- [1] Directorate General of Estate Crops 2019 *Tree Crop Estate Statistics of Indonesia 2018 - 2020 Pepper* (Jakarta: Secretariate of Directorate General of Estates)
- [2] Evizal R and Prasmatiwi F E 2019 Agroteknologi perkebunan lada Lampung *Revitalisasi Lada Lampung Sebagai Komoditas Warisan* Eds H Sudarsono and Erwanto (Bandar Lampung Aura Publishing) pp 113–136
- [3] Evizal R 2013 Status fitofarmaka dan perkembangan agroteknologi cabe jawa *J. Agrotropika* **18** 34
- [4] Yudiyanto, Rizali A, Munif A, Setiadi D, and Qayim I 2014 Environmental factors affecting productivity of two Indonesian varieties of black pepper (*Piper nigrum* L.) *Agrivita* **36** 278
- [5] Karmawati E, Ardana I K, Siswanto, and Soetopo D 2020 Factors effecting pepper production and quality in several production center *IOP Conf. Series: Earth and Environmental Science* **418** (2020) 012051
- [6] Sulok K M T, Ahmed O H, Khew C Y, and Zehnder J A M 2018 Introducing natural farming in black pepper (*Piper nigrum* L.) cultivation *Int. J. Agron.* **2018** 9312537
- [7] Krishnamurthy K S, Ankegowda S J, Srinivasan V, and Hamza S 2013 Influence of

- carbohydrates, mineral nutrients and plant hormones in alternate bearing of black pepper (*Piper nigrum* L.) *Am. J. Plant Sci.* **4** 1960
- [8] Daras U and Gusmaini 2016 Strategi mengatasi budidaya lada berpindah: Kasus lada Bangka Belitung *Perspektif* **15** 96
- [9] Evizal R 2000 Pola budidaya lada sistem panjatan hidup di Propinsi Lampung *J. Agrotropika* **5** 14
- [10] Prasmatiwi F E and Evizal R 2020 Keragaan dan produktivitas kebun lada tumpangsari kopi di Lampung Utara *J. Agrotropika* **19** 110
- [11] Manik T K 2009 Analisis deret waktu curah hujan untuk mengkaji perubahan iklim di daerah tangkapan air Propinsi Lampung *J. Agromet* **23** 61
- [12] Manik T K, Rosadi B, and Nurhayati E 2014 Mengkaji dampak perubahan iklim terhadap distribusi curah hujan lokal di Propinsi Lampung *Forum Geogr.* **28** 73
- [13] Krishnamurthy K S, Kandiannan K, Sibin C, Chempakam B, and Ankegowda S J 2011 Trends in climate and productivity and relationship between climatic variables and productivity in black pepper (*Piper nigrum*) *Indian J. Agric. Sci.* **81** 729
- [14] Wirantika R and Hariyono D 2019 Studi perubahan curah hujan dan hubungannya dengan produktivitas tanaman lada di Kabupaten Lampung Timur *J. Produksi Tanam.* **7** 1271
- [15] Asnawi R, Zahara, and Arief R W 2017 Pengaruh pengelolaan faktor internal usahatani terhadap produktivitas lada di Propinsi Lampung *J. Penelit. Tanam. Ind.* **23** 1
- [16] Togatorop S M, Haryono D, and Rosanti N 2014 Pendapatan dan tingkat kesejahteraan petani lada di Kecamatan Gunung Labuan Kabupaten Way Kanan," *J. Ilmu-Ilmu Agribisnis - J. Agribus. Sci.* **2** 268
- [17] Evizal R and Prasmatiwi F E 2005 Economic potentials of legume crops in plantation management *The Future Use of Legume Nodulating Bacteria (LNB) in Indonesia Technical and Economic Perspectives* Eds B. Arifin, H. Ismono, and M. Utomo (Bandar Lampung Universitas Lampung) pp 62-72
- [18] Bande L O S, Hadisutrisno B, Somowiyarjo S, and Sunarminto B H 2015 Epidemologi penyakit busuk pangkal batang lada pada kondisi lingkungan yang bervariasi *J. Hama Dan Penyakit Tumbuh. Trop.* **15** 95