Farmers perceptions on climate change in lowland and highland vegetable production centers of South Sulawesi, Indonesia

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Abstract. A survey was carried out in South Sulawesi, Indonesia interviewing 220 vegetable farmers. It was aimed at examining the vegetable farmers’ perception of climate change and assessing the consistency of farmers’ perception with available time series meteorological data. Results suggest that meteorological data analysis is in agreement with farmers’ perception regarding faster start, longer ending, and longer duration of rainy season. Further data analysis supports the claim of most farmers who perceive the occurrence of increasing air temperature, changing or shifting of the hottest and coldest month. Most respondents also suggest that climate change has affected vegetable farm yield and profitability. Other respondents even predict that climate change may affect the quality of life of their future descendants. Meanwhile, significant number of farmers is quite optimistic that they can cope with climate change problems through adaptation strategy. However, the attitude of farmers towards climate change is mostly negative as compared to positive or neutral feeling. Informative and educational campaign should be continuously carried out to encourage farmers in developing positive attitude or positive thinking towards climate change. Positive attitude may eventually lead to constructive behavior in selecting and implementing adaptation options.

1. Introduction
Climate change and variability are serious threats to sustainable development because of their potential negative impacts to environment, human health, food security, economic activities, natural resources and physical infrastructures [1, 2]. Impacts of climate variability are manifested as floods, drought, uncertain rainfall, and extreme events that have consequences on increasing uncertainties/risks of agricultural and food security programs, especially in developing countries [3]. Some crops, especially those grown in lowland areas, have been allegedly cultivated in environmental conditions that are very close to their tolerable maximum heat. Hence, slight changes in atmospheric heat or rainfall may lead to substantial decrease of crop yield [4].

Climate change in Indonesia has received much attention due to its standing as the world’s third largest emitter [5]. It is reported that the main sources of CO₂ emissions in Indonesia are deforestation, forest fires, and degradation of peat land. The impacts of climate change in Indonesia include, but are not limited to temperature increase, intense rainfall, a rise in sea-level, and a threat to food security [6]. Based on the simulation of climate data from 1971-2006, it is predicted that a combination of temperature increase and rainfall decrease will have significant impacts on the country’s food balance by 2050 [7].
Climate change adaptation may only be carried out when (a) farmers perceive that climate change is really happening, (b) farmers are able to identify adaptation options available, and (c) farmers respond to climate change adaptation in accordance to their production circumstances [8]. Hence, a complete understanding of farmers’ perception on climate change is very important since it may establish farmers’ readiness to adapt to climate change by considering some adjustments to their cultivation practices [9]. Most climate change perception studies deal with temperature and rainfall that include amount, annual distribution, start and end dates [10, 11]. Time-series meteorological data are often used in studies for confirming farmers’ perception or opinion regarding climate change [12, 13] or refuting them [11]. Other studies have dealt with perceptions of cropping seasonality, perceptions of production risks and threats related to climate variability [14, 15] and farmers’ local knowledge in forecasting weather and adapting to climate [16]. This study was aimed at examining the vegetable farmers’ perception of climate change and assessing the consistency of farmers’ perception with available time series meteorological data.

2. Materials and Methods
The study was conducted in vegetable production centers of South Sulawesi province, Indonesia. Focus Group Discussion carried out during preparation stage suggested that farmer respondents should be selected not only based on different agro-ecosystems (lowland < 400 m and highland > 700m above sea level), but also on different season-pattern sectors (western, eastern and transitional sector). Western sector is a part of South Sulawesi that has rainy season during the period of October-March and dry season during the period of April-September. Eastern sector has the opposite seasonal pattern, i.e. rainy season in April-September and dry season in October-March. Transitional sector constitutes regions that are characterized to have both seasonal patterns. Simple random sampling procedure was employed in selecting a total sample of 220 respondents with the distribution as follows: (a) lowland-western sector – 55 respondents, (b) lowland–eastern sector – 55 respondents, (c) highland-transitional sector – 55 respondents, and (d) highland land-western sector – 55 respondents.

The selected respondents were interviewed by using a structured questionnaire. Data collected mostly focuses on socio-economic characteristics of the respondents and perception and knowledge on climatic variables or climate change in general. Various questions were designed based on their specific purpose. These might include questions that only needed “yes” or “no” answer (dichotomous), and questions that their responses were rated in several levels of measurement.

Descriptive statistics that include mean, percentages and frequency counts was used to describe socio-economic features of the respondents’ perception about climate change. Chi-square test was used to analyze nominal data. Continuum-scale data, such as rainfall were analyzed by using simple regression. For statistical computation, ordinal-scale data were transformed to interval-scale data by using the method of successive interval (MSI) [17]. Meanwhile, the rank of importance of some factors was assessed by ranking method using multiple weighted score analysis [18].

3. Results and Discussions
3.1 Socio-economic characteristics of respondents
Table 1 showed that 61.9% of respondents were within the age range of 30-49 years. It was reported that 30% of respondents had tertiary education and 7.7% had even a BS degree. The study also showed that 88.2% of respondents had engaged in vegetable production as long as 1-20 years. These three characteristics suggested that most of the respondents were at productive age, quite educated and experienced.
Table 1. Age, education and experience of the respondents.

| Age (years) | % | School Level | % | Experience (years) | % |
|-------------|---|--------------|---|-------------------|---|
| < 20        | 5 | 2.3          | 1.4| 1 – 10            | 65.9|
| 20-29       | 32| 14.5         | 34.1| 11 – 20           | 22.3|
| 30-39       | 78| 35.5         | 25.0| 21 – 30           | 6.4 |
| 40-49       | 58| 26.4         | 30.0| 31 – 40           | 3.6 |
| 50-69       | 30| 13.6         | 7.7 | 41 – 50           | 1.4 |
| > 70        | 2 | 6.8          | 1.5 | 51 – 60           | 1.5 |

| ∑            | 220| 100 |
|--------------|----|-----|
| ∑            | 220| 100 |
| ∑            | 220| 100 |

3.2 Farmers’ perception on changes in rainy and dry season in the last five years

Most respondents perceived that rainy season started earlier (65.9%), ended later (58.2%), and had longer duration (60%) (Table 2). However, 47.3% of respondents indicated the less frequent occurrence of heavy rains and more frequent occurrence of drought.

Table 2. Farmers’ perception on changes in rainy and dry season.

| Variable                  | % | % | % |
|---------------------------|---|---|---|
| Start of rainy season     | 65.9| 10.0| 24.1|
| End of rainy season       | 30.5| 11.4| 58.2|
| Duration of rainy season  | 26.8| 13.2| 60.0|
| Frequency of heavy rain occurrence | 47.3| 18.2| 34.5|
| Frequency of drought occurrence | 41.4| 11.4| 47.3|

Since the p-value (0.000) was less than the significance level (0.05), then there was sufficient evidence to conclude that the proportion of respondents who expressed their perceptions based on three categorical choices was different (Table 3).

Table 3. Chi-squared test on changes in rainy and dry season.

| Indicator | start of rainy season | end of rainy season | duration of rainy season | heavy rain occurrence | drought occurrence |
|-----------|-----------------------|---------------------|--------------------------|-----------------------|------------------|
| Chi-Sq. (a,b) | 111.609 | 73.155 | 76.536 | 28.073 | 48.936 |
| df        | 2        | 2      | 2      | 2      | 2    |
| Asymp. Sig. | .000  | .000   | .000   | .000   | .000 |

3.3 Dynamics of rainfall in South Sulawesi based on meteorological data

Rainfall data during the period of 2001-2010 showed a continuing annual increase of rainfall starting in 2007 with the exception in 2009. The highest rainfall occurred in 2007 that reached about 300% of rainfall in the previous years. Extremely high coefficient of variation in 2007 explained the high variability of monthly rainfall occurred during the year. On the contrary, there was a relatively stable monthly rainfall in 2010 with an ample monthly rainfall average. Mapping the rainfall time-series monthly data also indicated that there was a shift in months with highest rainfall or lowest rainfall from year to year. The highest rainfall in 2001 and 2001 occurred in January had shifted one month
faster to December 2003. January as the wettest month of the year recurred in 2004, 2005 and 2006, but the month with the highest rainfall had also shifted one month faster to December 2007. Similar shifting was also happened for months with the lowest rainfall.

Simple regression analysis of rainfall and months in Table 4 indicated that there was a significant positive relationship (37.287) between rainfall and months. A one-unit increase in explanatory variable (month) caused a one-unit increase (37.3 mm) of dependent variable (rainfall).

Table 4. Linear regression of rainfall and month, 2001-2010

| Model | Un-standardized Coefficients | Standardized Coefficients | t | Sig. |
|-------|-------------------------------|---------------------------|---|------|
| 1 (Constant) | 2297.258 | 1015.925 | 2.261 | .026 |
| X_MONTH | 37.287 | 14.573 | .229 | 2.559 | .012 |

3.4 Farmers’ perception on changes temperature in the last five years

Most respondents perceived that air temperature was getting hotter (69.5%), number of hot-days per month became higher (69.1%), and the number of cold-days per month became lower (66.8%). It was also perceived some changes in the hottest month (75%) and the coldest month (78.2%) of the year.

Table 5. Farmers’ perception on changes in temperature.

| Variable | colder % | no change % | hotter % |
|----------|----------|-------------|---------|
| Air temperature | 36 | 31 | 153 |
| Number of hot-days per month | 45 | 23 | 152 |
| Number of cold-days per month | 147 | 29 | 44 |
| Hottest month | 165 | 55 | 55 |
| Coldest month | 172 | 48 | 48 |

The test results in Table 6 indicated that the p-value (0.000) was less than the significance level (0.05) implying that the null hypothesis could not be accepted. This meant that the proportion of respondents who expressed their perceptions based on three categorical choices was different.

Table 6. Chi-squared test on changes in air temperature

| Indicator | air temperature | no. of hot-days/month | no. of cold-days/month | hottest month | coldest month |
|-----------|-----------------|-----------------------|------------------------|--------------|--------------|
| Chi-Sq. (a,b) | 129.991 | 129.882 | 112.536 | 55.000 | 69.891 |
| df | 2 | 2 | 2 | 1 | 1 |
| Asymp. Sig. | .000 | .000 | .000 | .000 | .000 |

3.5 Dynamics of air temperature in South Sulawesi based on meteorological data

Temperature data during the period of 2002-2011 indicated that air temperature was increasing in 2005, decreasing in 2006, 2007 and 2008, and increasing again in 2009 and 2010. However, the highest maximum temperature (28.3°C) was actually occurred in 2006 and 2009. During those years,
months with the lowest temperature were mostly occurred in January-February, at least 7 times (2001, 2003, 2007, 2008, 2009, 2010 and 2011). Meanwhile, months with the highest temperature were mostly happened in October-November, at least 7 times too (2002, 2003, 2006, 2007, 2008, 2009 and 20110. Shifts or changes of months with lowest or highest temperature did not show fixed pattern. Months with lowest temperature could occur 4-5 months later, while months with highest temperature could occur 1-5 months earlier.

A significant positive relationship between temperature and months was confirmed by the t-value of 2.146 at p-value of 0.034 (Table 7). A one-unit increase in explanatory variable (month) caused a one-unit increase (0.005 °C) of dependent variable (temperature).

| Table 7. Linear regression of temperature and month, 2001-2010 |
|---------------------------------------------------------------|
| Model | Unstandardized Coefficients | Standardized Coefficients | t | Sig. |
|-------|-------------------------------|---------------------------|---|------|
| 1     | (Constant)                    | 1.421                     | .004 | 364.132 | .000 |
|       | LOGX_MONTH                    | .005                      | .002 | .185 | 2.146 | .034 |

- Dependent Variable: LOG Y_TEMPERATURE

3.6 Farmers’ attitude towards climate change

In the last 5 years, most respondents (95%) indicated that they had observed and experienced increasingly uncertain climate, weather and season. Most respondents also perceived that climate change had already affected farm yield or agricultural productivity (95%). About 93.6% of farmers even suggested that climate change had affected the profitability of their farms. High proportion of respondents (85.9%) stated their agreement suggesting concurrence among the farmers that climate change and variability might reduce the next generation quality of life. However, more than half of respondents (61.8%) inclined to have positive perception regarding farmers’ ability to adapt.

Farmers’ attitude to climate change becomes very important because it may affect their decision in taking actions and responding to challenges, incentives and rewards. About 19.1% of respondents were anxious or worried because climate change had created so many uncertainties. A significant proportion of respondents (43.2%) was not only anxious or worried, but also confused to deal with climate change. Figure 1 also showed some combinations of farmers’ attitude towards climate

**Figure 1. Farmers’ attitude towards climate change**

respondents were anxious or worried because climate change had created so many uncertainties. A significant proportion of respondents (43.2%) was not only anxious or worried, but also confused to deal with climate change. Figure 1 also showed some combinations of farmers’ attitude towards climate
change that could be grouped into (a) negative response – anxious/worried, sad, hopeless, (b) positive response – hopeful, and (c) neutral – not afraid, confused, do not know. Considering this grouping, it seemed that farmers’ attitude towards climate change was more dominated by negative response. Previous studies eliciting attitudes toward climate change or global warming consistently indicated similar response: anxious or worried in specific negative outcomes such as ocean level rise, more frequent storms, and possible water shortages [19, 20].

4. Conclusion

Most respondents in lowland and highland vegetable areas perceived that rainy season was started early, ended later and had longer duration in the last five years. An increasing trend of temperature and changes in the hottest and coldest month during the studied period were also perceived to be occurred by most respondents in all seasonal patterns. In this study, the results of meteorological data analysis were consistent with most farmers’ perceptions regarding some changes in climate. However, not all farmers’ perceptions were consistent with data analysis. For example, rainfall data analysis did not support the perception of most farmers in all seasonal patterns claiming that the occurrence of heavy raining was becoming less frequent. The contradiction might also be possible since human perception of climate was strongly influenced by expectations, which might have little relationship to the true nature of climate as provided by the instrumental records.

Almost all the farmers interviewed were aware of climate change, and recognize its impacts. Most farmers perceived that climate change had already affected farm yield. Increased in temperature and changes in rainfall pattern could fasten the spread of fungus and diseases directly or indirectly affecting yield and farm profit. Some respondents even perceived that climate uncertainty and variability had the potential of reducing the next generation quality of life. Nonetheless, there was a quite significant proportion of respondents who still had positive perception suggesting that all farmers would always have the ability to adapt.

Most of the farmers in the study area tended to show negative attitudes towards climate change. Negative attitudes reflected lack of farmers’ knowledge and information regarding climate change. This was actually a bit contradictory since most farmers had recognized extreme climate events such as floods and droughts due to climate change. To some extent, farmers were quite knowledgeable about climate change, but seemed to be in confusion as to the more technical or scientific aspects of climate change. Therefore, various informative and educational efforts should be carried out to encourage farmers for developing positive attitudes and showing constructive behavior and actions for climate change adaptation.

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