The preliminary study of farmers' perception on changing climate effect to agricultural cultivation
Case study: grape farmers in Takahata city, Yamagata prefecture, Japan.

Tohoku University Graduate Student ○Soliya Sopha
Tohoku University Member Komori Daisuke
Yamagata and Takahata officers of Agriculture, Forestry and Fisheries Horticulture Promotion Division Non-member Shinsuke Furuno
Yamagata and Takahata officers of Agriculture, Forestry and Fisheries Horticulture Promotion Division Non-member Eisuke Adachi
Yamagata and Takahata officers of Agriculture, Forestry and Fisheries Horticulture Promotion Division Non-member Noriko Kaneda

I. Introduction

Agriculture is always vulnerable for changing climate (Adger et al., 2007). In Japan, the annual precipitation and temperature have been changed during the last decades (JMA., 2011). These changes are likely to affect fruit trees, vegetables and rice cultivation (Sugiura et al. 2012). Hence, previous studies have researched the factors that drive farmers' adaptation to these changes (Hycent et al, 2011; Fujisawa et al, 2013). Farmers' awareness of the changing climate would help to develop appropriate adaptation strategies (Sujata et al., 2015). Therefore, the objectives of this research are to investigate climatic conditions impact to grape cultivation and to compare farmers' perception of climate impact on grape production. To do so, grape farmers in Takahata city, Yamagata prefecture, Japan were selected as the case study.

II. Study area

Takahata city is the largest area of grape cultivation in the Tohoku region (MAFF 2016), the total areas of grape farming are 268 hectares – consisting of 461 grape farmers (Takahata Town Hall Agriculture, 2018).

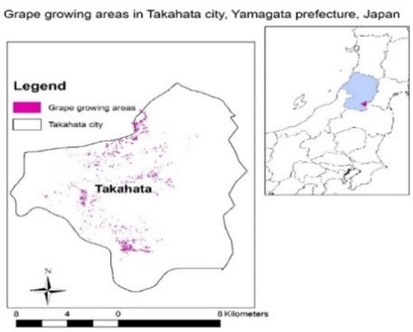

Figure 1: Location of study area

III. Methodologies

- ❑ Data collection and analysis

✓ Primary data: The qualitative data collection has been conducted. Face to face interviews with farmers who have major income from grape cultivation have been finished. The data has been analyzed and explained by using descriptive methods.

✓ Secondary data: Quantitative data, the historical data of grape yield and climate data over the last 38 years (1977-2015) have been collected. Then, grape yield data has been classified into two groups namely high and low yield years. The climatic observation data has been classified into 10 variables based on the grape planting seasons (A.Kobayashi et al, 1968; Santos et al, 2011). The set of data has been analyzed and compared to find out the different climate of high and low yield years by applying the Principle Component Analysis (PCA).

IV. Results

Principle Components Analysis (PCA) of climatic variables in years with high and low yields.

The PCA results showed in Table 1 and 2, they obtained three Principle Component (PC), which the standard deviations were greater than 1 and the cumulative proportions were exceeded by 79%.

The high yield years showed in Table 1, the first principle component (PC1) had a high negative correlation with rainfall in July and September (berry development and maturity phases), which meant there were less rainfall in those months. The PC2 had a high positive correlation with mean temperature in May and July, it also showed a high negative correlation with rainfall of these months. Therefore, it was concluded that there were warm temperature and less rainfall in May and July. The PC3 had a positive correlation with mean temperature in June. This determined about there was a warm climate in June. Table 2 showed the principle component in years with low yield. The first principle component (PC1) had a negative correlation with mean temperature in April and May (shooting and flowering phases), and it had a positive correlation with rainfall in July and September. We concluded that there were heavy rainfall and cold temperature in those months. The PC2 had a positive correlation with rainfall in April and May – meaning that it was high rainfall amount in both months. Meanwhile, the PC3 had the highest positive correlation with mean temperature in June, which concluded about warm climate.

Key word: farmers' perception, adaptation, changing climate, agricultural cultivation.

Graduate School of Environmental Studies, TOHOKU UNIVERSITY, Hydro-Environment System Laboratory; 6-6-06, Aoba-Yama, Sendai, 980-8579 JAPAN; sopha.soliya.r6 *@dc.tohoku.ac.jp* Tel: 090-9394-3205;

Table 1: Principle component analysis in years with high yield

Climatic parameters (factors loading)	PC1	PC2	PC3
Standard deviation	***1.75***	***1.66***	***1.14***
Cumulative proportion	***0.3***	***0.58***	***0.79***
mean.temp.Apr	-0.24	0.04	-0.30
mean.temp.May	-0.24	0.43	-0.11
mean.temp.June	0.17	-0.01	0.64
mean.temp.Jul	0.2	0.44	0.16
mean.temp.Aug	-0.11	0.3	-0.05
rainfall.Apr	-0.35	0.14	0.2
rainfall.May	0.1	-0.47	-0.25
rainfall.Jul	-0.37	-0.36	0.11
rainfall.Sep	-0.42	-0.06	-0.19
rainfall.Oct	0.26	0.34	-0.04

Table 2: Principle component analysis in years with low yield

Climatic parameters (factors loading)	PC1	PC2	PC3
Standard deviation	***1.96***	***1.87***	***1.13***
Cumulative proportion	***0.38***	***0.74***	***0.87***
mean.temp.Apr	-0.41	-0.02	-0.32
mean.temp.May	-0.41	0.12	-0.2
mean.temp.June	-0.20	-0.19	0.66
mean.temp.Jul	-0.06	0.4	0.23
mean.temp.Aug	-0.07	0.4	0.28
rainfall.Apr	-0.15	0.42	0.26
rainfall.May	-0.11	0.36	-0.38
rainfall.Jul	0.4	-0.17	0.02
rainfall.Sep	0.33	-0.21	-0.11
rainfall.Oct	-0.30	-0.35	0.19

Farmers' perception of climatic impacts on grape cultivation

Farmers' perception of climatic impacts on grape production showed in Table 3. In low yield years namely, 2008, 2012 and 2015, farmers noted that there were heavy rainfall and snow. In these years, there were high amount of rainfall in July and September (315 to 627mm/month), which were higher than average rainfall (127 to 157 mm/month) during 1990-2015 (JMA, 2017). Moreover, in those years, there also had a low temperature in March and April (-2.58 to -4.17 °C). It was lower than average temperature, which were between -0.7 to 3.5 °C (JMA, 2017). Conversely, farmers perceived that in some years such as 2007, 2010 and 2014, they got high yield. They mentioned that there was less rainfall in summer. In those years, the amount of rainfall in July and September were between 134 to 219 mm/month (JMA, 2017); and the temperature in March and April were among -1.82 to 2 °C (JMA, 2017).

We compared these results with the PCA results. The PC 1 illustrated that the high yield years had less rainfall in July and September. Nevertheless, the low yield years had heavy rainfall in July and September. Furthermore, PC2 and PC3 showed warm climate in both high and low yield, these were not recognized by farmers that impact on grape production.

Table 3: Farmers' perception of climatic impacts on grape production compared with climatic observation data analysis by PCA.

Descriptions	Number of farmers	Farmers' perception	Climatic observation data (JMA, 2017)	Principle Components Analysis (PCA) results
High yield	6	Year: 2007, 2010, 2014 Less rainfall	Rainfall in July to September: 134 to 219 mm/month The temperature in March to April: -1.82 to 2 °C	PC1: less rainfall in July & September
Low yield		Year: 2008, 2012, 2015 Heavy rainfall or heavy snow	Rainfall in July to September: 315 to 627mm/month The temperature in March to April: -2.58 to -4.17 °C	PC1: cold temperature in April & May Rainfall in July & September

V. Conclusion

Farmers' perception of climatic impacts on grape production was matched with the PC1 of PCA results. For adaptation to heavy rainfall in July to September, farmers have built the greenhouses. In addition, due to heavy snow, farmers have adopted the heating system inside the greenhouse. That is to melt the snow and control the appropriate temperature. By doing so, farmers could start early grape planting and get harvesting before heavy rainfall in summer. On the other hands, farmers did not mention any warm climate related to grape cultivation, which are detected by PC2 and 3. Thus, both PCs might not work for improving innovations and adaptation. We also concluded that the significant climatic parameters namely, heavy rainfall and snow have motivated farmers' adaptation and adoption to innovations.

Acknowledgement: Authors sincerely acknowledge the Japan Agriculture Cooperative (JA-COOP) who participated in discussions as well as facilitator of data collection process and coordination with farmers.

References

1. Fujisawa M, Kobayashi K., 2015. Shifting from apple to peach farming in Kazuno, northern Japan: perceptions of and responses to climatic and non-climaticimpacts. Reg Environ Change. 13(6):1211–1222.
2. Japan Meteorological Agency (JMA), 2017. Statistic of climatic information, http://www.data.jma.go.jp/gmd/risk/obsdl/#!table.
3. Kobashi et al., 1968. Favorable day and night temperature combination for the fruit growth of Delaware grape and Satsuma oranges. Division of Pomology, Kyoto Uni.