

Estimating the Shift in Suitable Lands for Apple and Citrus Unshiu Cultivation Caused by Global Warming

Abstract

The extent of the effects of global warming on apple and citrus unshiu cultivation were estimated by using a time series on the average annual changes in temperature. The results revealed that the areas suitable for their cultivation will gradually move northward and that by the mid-21st century the climate could become unfavorable to most present-day major production areas.

Keywords: Apple, citrus unshiu, global warming, mesh climate map, estimation for suitable land

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Background and Purpose

Fruit production, which is very much dependent on climatic factors, will be considerably affected by global warming through the increase of greenhouse gases in the atmosphere. In order for researchers, administrators, and producers to plan necessary countermeasures, there is a need to illustrate the projected scale of the impact and its time schedule regardless of the influence, or the lack thereof, of global warming. This study sought to simulate the production environment of apples and citrus unshiu, both majorly grown in Japan, for the next 60 years using an approximately 10×10km mesh.

Achievements and Features

1. The “Climate Change Mesh Data” (Yokozawa, et al., 2003), obtained from the estimated results of four meshed climate models, was used to analyze the predicted climate value, while the “Mesh Climate Data” values (Meteorological Agency, 2002) was used for the analysis of the present value. The temperatures in the database were averaged for each mesh and period relating to the four climate models. From the resulting figures, the mesh corresponding to the particular temperature range is selected and analyzed using a program illustrating the area on the map.
2. A suitable area for apple cultivation should have an annual average temperature of 6°C to 14°C as was set by government guidelines (Fruit Farming Promotion Policy,

2000). At present, this area covers a rather extensive part of Japan excluding only northern and eastern Hokkaido and the warm southwest plains. Yet, southern Tohoku by the 2040s and plain areas of Hokkaido by the 2060s is expected to have temperatures over 14°C. While by this time, almost all areas of Hokkaido will be suitable for apple growing. Since the given temperature range covers a much greater area than the present major production areas, a narrower range of 7°C to 13°C was also investigated. Southern Hokkaido and the mountainous regions of the Chubu region, which are at present the major producers, fit this temperature range. But, by the 2060s, almost all of the Tohoku plain areas will fall outside of this range, and the temperatures in most of the present production areas are expected to be as high as those in warm-apple producing regions (Figure 1).

3. The temperature range suitable for citrus unshiu production as was set in the government guidelines is 15°C to 18°C. This includes the coastal areas of southeast Japan, which coincide with present major production areas. By the 2020s, this temperature range will cover the coastal areas of the San'in region. And by the 2040s all plain areas of the Kanto and Hokuriku regions. The coastal areas of south Hokuriku by the 2060s will then come under this temperature range. (Figure 2). At present, areas with over 18°C in ambient temperature are limited to the southwestern islands and southern tip of Kyushu, but by the 2060s, the temperatures in most of the present production areas are projected to reach more than 18°C, similar to or higher than that for medium or late-maturing citrus.

Application and Notes

1. These results can be used as basic data for research into designing countermeasures, for drawing up planting plans or on studies for assessing the impact to the rural economy.
2. The Global Climate Models include rapid and slow-progressing global warming scenarios. The 4 models used in this study considered the medium-speed scenario.
3. The estimates made in this study were based on the annual average temperature. It is, nonetheless, also important to examine other various elements such as temperature extremes during winter, precipitation, amount of sunlight as well as those relating to soils for those areas classified as suitable in these estimates.
4. The effects of global warming on the fruit trees already planted should be the next subject for research.

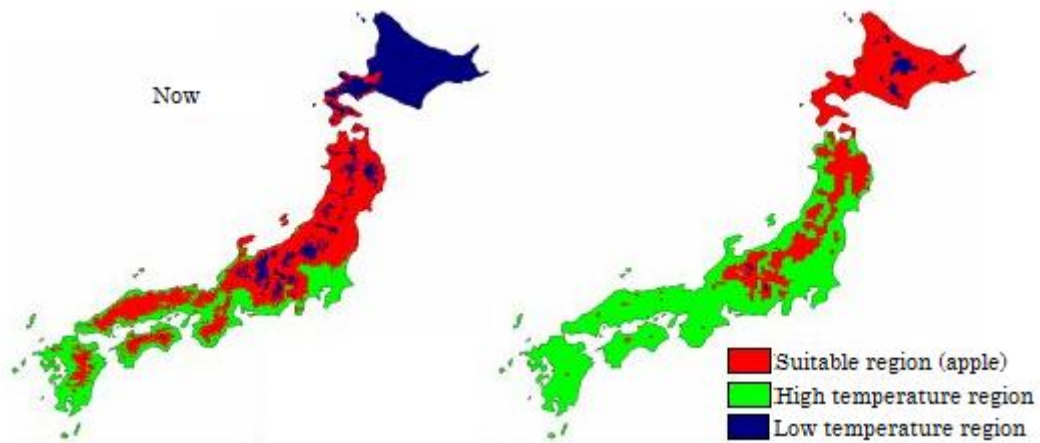


Figure 1. The shift of temperature range (7°C ~13°C) suitable for apple cultivation caused by global warming. The current value is the average temperature from 1971 to 2000.

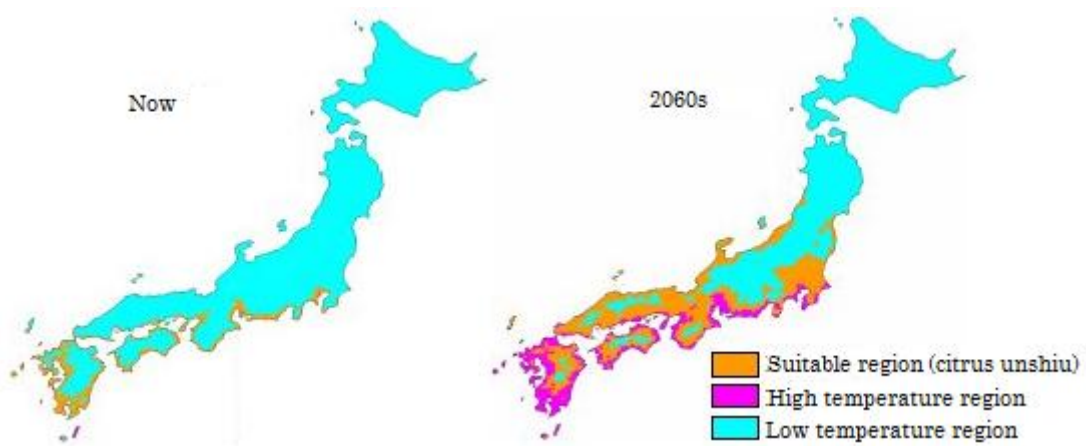


Figure 2. The shift of temperature range (15°C ~18°C) suitable for citrus unshiu cultivation caused by global warming. The current value is the average temperature from 1971 to 2000.