

SECTION 1

Introduction: The Policy and Planning Issues

1.1. Background and Purpose

The influence of climate on agriculture in Japan is quite striking. Its influence on rice production is especially important because rice is the main staple in Japan and, being a tropical plant, is grown close to its limits of tolerance to low temperatures in the northernmost regions of the country.

Almost all the rice produced in Japan is cultivated in paddy fields flooded with water that is supplied through well developed waterways. Thus, unlike most other countries in the world, water hardly plays a role as a yield-reducing factor in Japanese rice production. The major climatic factors that significantly influence rice production are temperature (especially in the north), strong winds and heavy rainfall associated with typhoons, and solar radiation. The location and timing of the typhoon damage is unpredictable, but as a whole Japan loses a certain amount of rice production every year through their effect. Typhoon damage is considered to be unavoidable, and typhoons themselves bring much precipitation that is necessary for production of rice.

Some of the greatest losses to rice crops result from cool summer conditions that occur quite frequently in northern Japan (particularly in Tohoku and Hokkaido districts, where mean July–August temperature ranges from 18 to 20°C). Low summer temperature can result in delay of growth, reduced plant height, or sterility of the grains of rice plants. If the temperature of irrigation water is lower than 18°C this may also obstruct growth and result in standing green plants remaining in autumn that are unsuitable for harvesting. It has been estimated that, for example, cool summer damage occurs somewhere in Tohoku district about one year in four, and in Hokkaido the frequency is higher still.

During the last 20 years, the position of agriculture in the national economy of Japan has been rapidly declining. For example, the proportion of those engaged in agriculture to the total active population was 26.8% in 1960 but

11.2% in 1975. During the same period, the contribution of agriculture to the gross domestic product decreased from 10.2% to 5.0%. The basic relationship between climate and rice production has, however, altered very little. Year-to-year variations in rice production due to climate remain significant.

The purpose of this case study is to quantify the effect of both short- and long-term climatic changes on Japanese agriculture and, in particular, to study how variations in climate influence rice yields and how these variations in yields can affect national agricultural production. In common with other case studies in the IIASA/UNEP project these estimations (a) involve experiments with a hierarchy of models – climatic, crop-yield and economic – and (b) are derived for different climates described by meteorological data from recent warm and cool periods and, as a special case, for the climatic conditions estimated for a doubled concentration of atmospheric carbon dioxide by the Goddard Institute for Space Studies (GISS) general circulation model (Hansen *et al.*, 1983, 1984).

This introduction provides background information on the physical environment and agriculture in Japan, and outlines considerations behind the selection of the crops, regions and models used in this study.

1.2. The Environment and Agriculture in Japan

1.2.1. Topography and ocean currents

The Japanese Islands extend in a southwest-northeast direction through 22 degrees of latitude, from 24 to 46°N over a distance of about 2200 km; i.e., from the subtropical to alpine zones. The total land area is 369 883 km², of which the four main islands, Honshu (227 414 km²), Hokkaido (78 073 km²), Shikoku (18 256 km²) and Kyushu (36 554 km²), make up the major proportion (*Figure 1.1*). All the islands are mountainous or hilly and the flat lowland plains tend to be very narrow features found mostly along the coast and banks of larger rivers. The rivers on the islands are commonly very short and even the longest, the Shinano River, is less than 400 km. The area under cultivation comprises only 17% of the total land area.

The most important water mass near Japan is the Pacific Ocean, because of its physical influence on Japanese climate. Between the Japanese Islands and continental Asia lies the Sea of Japan, enclosed by the central arc of the Japanese Islands to the south and east and by the Korean Peninsula to the west. The Sea of Okhotsk, to the north of Japan, is bounded to the East by the island chain of the Kurils and the Kamchatka Peninsula. It is the source region of the cold and moist Okhotsk air mass, which exerts a considerable effect on the weather and climate of northern Japan. In contrast to the two above-mentioned seas, the East China Sea is merely a marginal stretch of shallow water lying on the continental shelf (*Figure 1.2*).

Three principal oceanic currents wash the shores of the Japanese Islands: the warm Kuro-shio, cold Oya-shio, and warm Tsushima Currents, and each has a strong influence on the climate. The Kuro-shio or Japan Current is the most important, carrying a total water volume of some $3\text{--}5 \times 10^7 \text{ m}^3/\text{s}$, together with