CLIMATE CHANGE ADAPTATION PLAN OF THE MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES (OUTLINE)

October 2021

Ministry of Agriculture, Forestry and Fisheries

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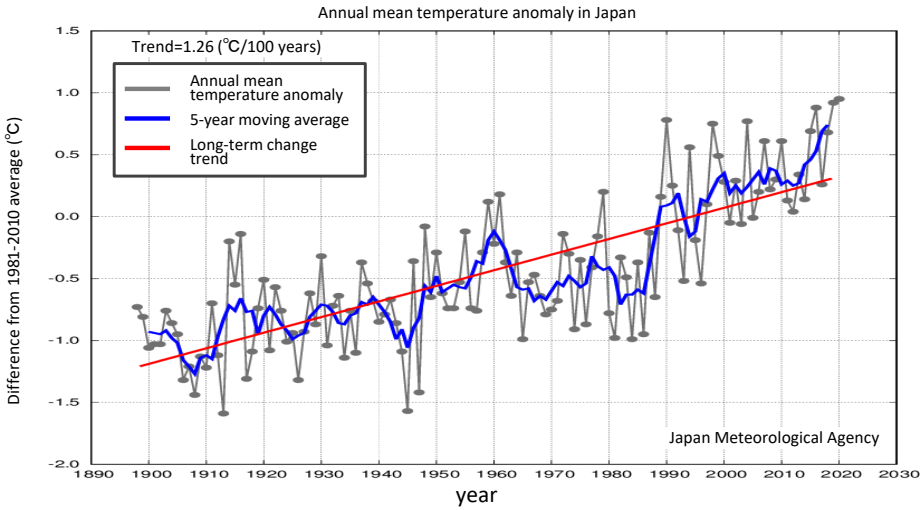
Climate Change and Increase in large-Scale Natural Disasters due to Global Warming

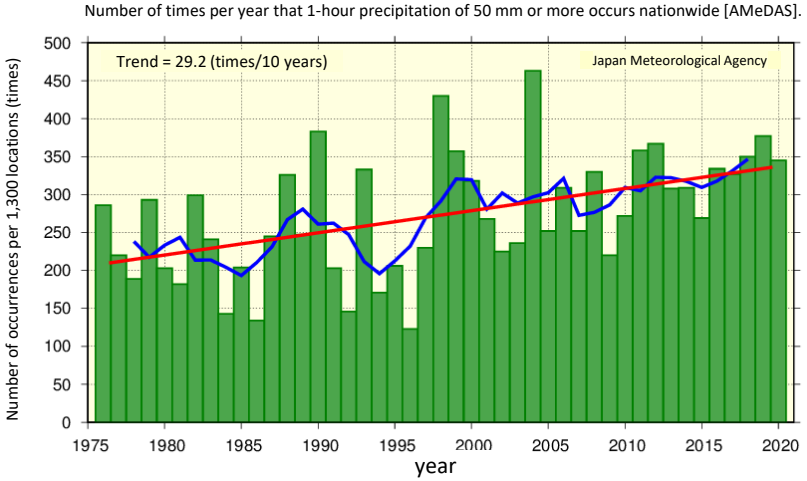
○The annual average temperature in Japan increases at a rate of 1.26°C per 100 years.
The annual average temperature in Japan in 2020 is the highest since statistics began being recorded in 1898.
○The agriculture, forestry and fisheries industries are susceptible to climate change and have already experienced quality deterioration due to high temperatures.
○Due to the increase in rainfall and other factors, disasters tended to be more severe. Damage also occurred in the agriculture, forestry and fisheries sectors.

■ Secular change in annual mean temperature anomaly in Japan



Annual average temperature has been increasing for a long period of time, and especially since 1990, there have been frequent high temperature years.

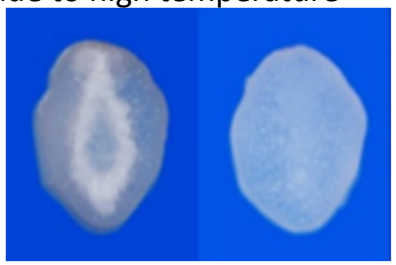
■ Number of times there was an hourly precipitation of 50 mm or more per year



The average number of occurrences over the 10-year period 2011-2020 is 334
Increased by 1.5 times compared to 1976-1985

■ Impacts of climate change on the agricultural sector

Rice: deterioration in quality due to high temperature



Cross section of white immature grain grain with white portion (left) and normal grain (right)

Apples: poor coloration and delayed coloration at maturity

■ Damage to the agricultural sector

Soaked cucumber
(Heavy rain caused by a front in August 2019)

A damaged glass house
(Typhoon on the Boso Peninsula in 2019)

Development and Promotion of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

Government-wide movement on climate change adaptation measures

(Impact Assessment)
March 2015 "First Climate Change Impact Assessment" was released (Ministry of the Environment)
(Planning)
November 2015 Cabinet approved the "Climate Change Adaptation Plan" (administrative plan)

(Legislation)
June 2018 Climate Change Adaptation Act promulgated.
(Planning)
November 2018 Cabinet approved the Climate Change Adaptation Plan based on the Act.

(Impact Assessment)
December 2020 the "Second Climate Change Impact Assessment" was released (Ministry of the Environment)
(Plan revision)
October 2021 Cabinet approved the revised "Climate Change Adaptation Plan"

History of the formulation and revision of the MAFF Climate Change Adaptation Plan

(Planning)
August 2015: Ministry of Agriculture, Forestry and Fisheries formulates climate change adaptation plan

(Plan revision)
November 2018: Revised Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

(Plan revision)
October 2021: Revised Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

Key points of the second round of climate change impact assessment

○Enhancement of scientific knowledge on the impacts of climate change
In the field of agriculture, forestry and fisheries, 339 references were cited**, about 3.5 times** as many as in the previous survey (96 references in the previous survey).
(new predictions)

- Poor coloring of grapes
- Decreased production capacity and reproductive function of livestock
- Increased flood damage in low elevation paddy fields
- Simultaneous collapse of hillside slopes and increase in mudslides
- Decline in algae and shellfish aquaculture production due to changes in the distribution areas of migratory fish and increases in water temperature
- Many studies see global rice, wheat, soybean, and corn yields declining, but impacts vary by region, CO2 concentration, and adaptation measures

Key points of the revised MAFF climate change adaptation plan

○ Promote the development and dissemination of stable production technologies and varieties that adapt to climate change based on Strategy for Sustainable Food Systems.
・In apples and grapes, the introduction of excellent coloring varieties, etc.
・Promotion of measures against heat, such as watering and ventilation in barns
○ Maintaining and improving of disaster prevention and mitigation functions in rural areas
○ Prevention of mountain disasters through the deployment of erosion control facilities and forest maintenance, etc.
○ Improvement of the precision of stock assessment and development of algae tolerant to high water temperatures, etc.
○ Establishing comprehensive food security by conducting research and analysis of food supply and demand, etc.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Basic Concept]

Plan development based on current and future impact assessment	○ Develop plans to respond accurately and effectively to the impacts of climate change, consistent with government-wide impact assessments ○ Organize and promote plans for each field and item, focusing on initiatives necessary for the next 10 years.
Countermeasures to the impact of global warming	○ Research and development of adaptive technologies and varieties that reduce the decline in production quantity and quality of crops, etc. ○ Conversion to adaptable varieties and crops, and dissemination of adaptation technologies
Disaster prevention and response to disasters caused by extreme weather events	○ Severe flooding damage to agricultural land and mountain disasters caused by torrential rains, etc. ○ Increased risk of storm surge due to rising sea levels, etc. } In preparation for this, it will systematically promote the development of facilities that contribute to disaster prevention.
Utilization of climate change	○ Expansion of production area due to reduction of low temperature damage ○ Introduction and conversion of subtropical/tropical crops and creation of producing areas ○ Increase in yield due to expansion of growing period and cultivation area by shortening snow cover period
Collaboration among stakeholders and role sharing, information sharing	○ National government: Scientific assessment of current and future impacts of climate change, basic research and development of adaptation technologies, presentation of supportive measures for local initiatives in terms of both software and hardware, and collection and dissemination of domestic and international information. ○ Regions: Independent selection and promotion of adaptation measures by regional entities, etc. ○ Effective implementation of adaptation plans through cooperation between national and local governments
Promote initiatives by continuously reviewing and optimizing the plan	○ Review of the current status and future impacts assessment based on the latest scientific findings in the wake of new reports by the IPCC and other organizations. ○ Confirmation of the progress of adaptation measures and reflection of the latest research results, etc. } Ongoing review of the adaptation plan based on the results of these latest assessments, etc.

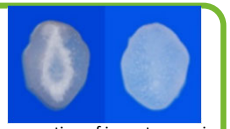
Major Adaptation Measures in the Agriculture, Forestry and Fisheries Sectors

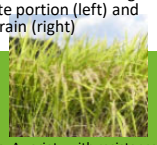
- **The agriculture, forestry and fisheries industries are susceptible to climate change, and have already been facing growth problems and quality deterioration due to high temperatures.**
- **Climate change may concurrently present some positive effects on these sectors, such as the expansion of cultivation areas for some crops due to rising temperatures.**

Photo source: MAFF, etc.

Paddy rice

・Deterioration in quality due to high temperatures.
・If the conversion to high temperature resistant varieties does not proceed, the percentage of the first-class rice may decrease nationwide.


Cross section of immature grain with white portion (left) and normal grain (right)


Hiroshima Prefecture: A variety with resistance to high-temperature "Koi-no-yokan"

・Development and dissemination of high temperature resistant varieties.
・Thoroughly implement basic techniques such as fertilizer and water management.

Livestock and forage crops

・During the summer, milk production, milk composition, and reproductive performance of dairy cattle decline, and the body mass index of beef cattle, pigs, and poultry deteriorates.
・Dry matter yields of forage crops are increasing year by year in some areas.


Kyoto Prefecture: Development of clothing for livestock using cool touch materials for humans

・Promotion of measures against heat, such as watering and ventilation in barns
・Development of productivity-enhancing technologies such as appropriate nutritional management
・Construction of cultivation system for forage crops, development and dissemination of cultivation management technology

Forestry

・Occurrence of woody debris flow accompanying hillside collapses triggered by external forces that exceed forests' ability to stabilize slopes.
・Possible increased risks of mountain disasters such as hillside collapses and debris flow due to more frequent heavy rainfall.
・Possible increase in growth problems of Japanese cedar planted forests in areas with already lower precipitation.


Large-scale mountain disaster caused by heavy rain


Withering cedar trees due to drought

・Prevention of mountain disasters including through erosion control facility deployment and forest management.
・Research and study on climate change impacts on forests and forestry

Fruit tree

・Poor skin color of apple and grape, peel puffing and sunburn of satsuma mandarin, and flowering disorder of Japanese pear.
・There is a possibility that the suitable areas for apple and satsuma mandarin cultivation will shift year by year.

Poor skin color of apple


Peel puffing of satsuma mandarin

・Introduction of superior-colored cultivars or yellow-green cultivars for apple and grape.
・convert to medium-late maturing citrus ('Shiranuhi', etc.), which prefer warmer climates to satsuma mandarin.


'Shiranuhi' have been developed by National Agriculture and Food Research Organization (NARO)

Agricultural production base

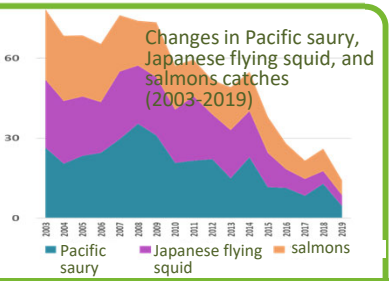
・In addition to the frequent occurrence of short duration heavy rainfall, drought due to low rainfall also occurred.
・A change in the timing of rice planting and an increase in water management labor.
・The risk of waterlogging damage to farmland may increase.


waterlogging damage to farmland caused by torrential rain

・Efficient use of agricultural water and maintaining and improving of disaster prevention and mitigation functions in rural areas through appropriate combination of hard and soft measures.

Fisheries

・Decline in catches of Pacific saury, Japanese flying squid and salmons.
・Mass death of scallop and oyster
・Decreased harvest of cultured laver due to shorter cultivation period.
・Changes in the distribution area and body size of migratory fish stocks, and possible impact on fish farming areas due to the rising water temperatures in summer.



・Comprehend the impact of marine environmental changes on fishery resources and improve the precision of stock assessment
・Improvement of aquaculture breeds tolerant to higher water temperatures and technology for monitoring harmful algal blooms over wider areas

《Examples of KPIs》
【Agriculture (paddy rice)】Percentage of area planted with high temperature resistant varieties (staple food rice)
【Forestry (timber production (plantation forests, etc.))】Percentage of prefectures where the pine weevil damage rate in pine forests to be conserved is kept at "slight damage" of less than 1%.
【Fishery (Migratory fish stocks (Ecology of fish, etc.)】Number of fish species assessed based on MSY (Maximum Sustainable Yields)

Examples of Leveraging the Opportunities Presented by Climate Change

Blood orange (Ehime, Japan)

In the Nanyo region of Ehime Prefecture, efforts have been made since around 2003 to introduce and popularize blood orange ("Tarocco" and "Moro") in order to deal with the impact of global warming and citrus anniversary supply, and steady production has been promoted.
(Cultivation area (Ehime Prefecture): 2008: 13.5 ha → 2018: 27.3 ha)

Peach (Aomori Prefecture)

In the Central South Region, which accounts for 70% of the apple cultivation area in Aomori Prefecture, the production of peaches has been promoted in recent years, and efforts are being made to study promising varieties and improve cultivation techniques for high-quality production and branding.
(Cultivated area (Aomori Prefecture) 2007: 91.4 ha → 2018: 122.2 ha)

Avocado (Ehime, Japan)

The introduction and spread of avocados has been promoted in the island and coastal areas of Matsuyama City, Ehime Prefecture since around 2008.
(Cultivation area (Ehime Prefecture): 10.8 ha in 2018)
In the future, the goal is to establish cultivation techniques for stable production and to expand the cultivation area to 10 ha in 2025.

Japanese cypress (Yamagata Prefecture)

As part of the project to introduce warm-season crops, a field experiment is underway to test the tree mortality of Japanese cypress, a tree species hitherto considered unsuitable in Yamagata, monitor their growth and occurrence of damage caused by climatic conditions, insects and wildlife, and explore the possibility of its introduction at scale.

Atemoya (Mie Prefecture)

In order to develop a subtropical fruit tree specialty that takes advantage of the mild climate of Mie Prefecture, we have studied the adaptability of Atemoya to cultivation, selected an excellent variety, and established cultivation techniques for stable production.
Although facility cultivation is required, it can be cultivated in winter with enough heat to prevent freezing, and we are working on its production in the prefecture. (Cultivation area (Mie Prefecture): 12a in 2020)

Processed yellowtail products (Hokkaido)

Since 2011, the increase in yellowtail landings in Hokkaido (Hakodate Port, etc.) has been utilized to develop processed products.

(Landings of yellowtail [fresh and processed] in Hokkaido: 2,190 tons in 2010 → 10,817 tons in 2019)

Outline of the MAFF Climate Change Adaptation Plan [Examples of Climate Change Predictions in Japan]

Temperatures

○ Annual average temperatures at the end of the 21st century* will increase by an average of 1.4-4.5 ˚C nationwide compared to the end of the 20th century**, depending on the forecast scenario.

○ As temperatures rise, the annual number of extremely hot days increases in many areas of Japan

(* End of 21st century: average of 2076-2095
** End of 20th century: 1980-1999 average)

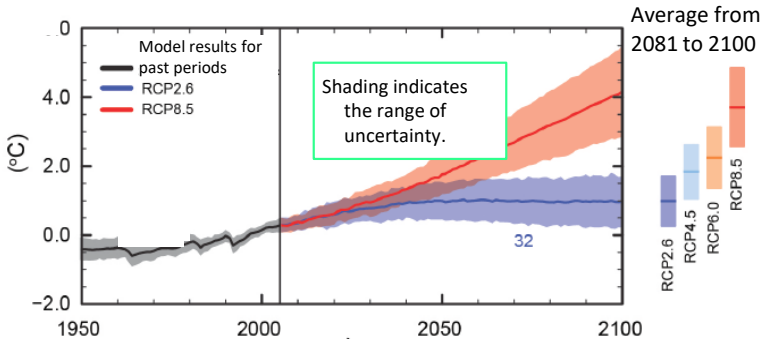


Figure: Image of average surface temperature change by prediction scenario (global average)

Source: IPCC Fifth Assessment Report Summary for Policy Makers

※RCP (Representative Concentration Pathway)
Scenarios that include time-series data on emissions and concentrations of greenhouse gases, etc.
- RCP2.6: Severe mitigation scenario (2 ˚C rise scenario)
- RPC4.5, RCP6.0: Intermediate scenario
- RCP8.5: Scenario with very high GHG emissions (4˚ C rise scenario)

Rainfall

○ The frequency of heavy and short duration rainfall will increase nationwide.
○ The rainy season precipitation zone in early summer (June) is expected to intensify and be located farther south than at present.

Tropical cyclone

○ Increase in the proportion of very intense tropical cyclones to all tropical cyclones worldwide
○ Typhoon strengthens near Japan
○ No change in the total annual amount of rainfall associated with typhoons near Japan, but an increase in the amount of precipitation from individual typhoons

Snowfall and snow accumulation

○ The amount of snowfall and the deepest snowfall of the year are decreasing.
○ In some areas, snowfall during severe winters increases as water vapor increases due to rising temperatures.

Seawater temperature

○ Annual average sea surface temperatures in the seas around Japan increased by 1.1 to 3.6 ˚C.

Sea level

○ Annual average sea level rise of 0.39 to 0.71 m along the Japanese coast

Outline of the Climate Change Adaptation Plan of the MAFF [Agricultural Production Review]

Impact

	seriousness	urgency	certainty	impact
Paddy rice	●	●	●	Cultivation and livestock farming are susceptible to climate change. Climate change can be the cause of growth disorders and quality deterioration in various crops and livestock.
Fruit tree	●	●	●	
Land use crops (wheat, soybeans, etc.)	●	▲	▲	
Horticultural crops (vegetables, flowering plants)	◆	●	▲	
Livestock farming	●	●	▲	
Pests, weeds, etc.	●	●	●	
Agricultural production infrastructure	●	●	●	

Legend:

[Seriousness]	●: Extremely serious impact is recognized.	◆: Impact is recognized		- : Cannot be assessed at present
[Urgency]	●: High	▲: Medium	■: Low	- : Cannot be assessed at present
[Certainty]	●: High	▲: Moderate	■: Low	- : Cannot evaluate at present

Note: Severity, urgency and certainty in the table above are excerpts from the "Climate Change Impact Assessment Report" (published by the Ministry of the Environment in December 2020).

Countermeasures

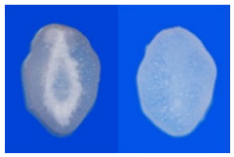
General agricultural production initiatives	Efforts by Item
○Development and dissemination of cultivation stabilization technologies and corresponding technologies, including the conversion of varieties and commodities, in order to avoid and mitigate damage caused by climate change. ○Farmers' own risk management for climate change and other efforts to reduce risks to agricultural production ○Demonstration of the introduction of new adaptive technologies ○Monitoring the impact of global warming in cooperation with local communities ○Dissemination of information through the Global Warming Impact Study Report, the Ministry of Agriculture, Forestry and Fisheries website, etc.	[Rice, fruit trees, pests, weeds, etc]. ○More focused efforts based on the fact that the climate change impact assessment report identified the significance as particularly large and the urgency and certainty as high (see table above). [Other crops] ○Continue to work on measures that have been taken in the past. ○Development of new adapted varieties and cultivation management techniques, or basic research for them, based on the forecast of future impacts.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Paddy Rice]

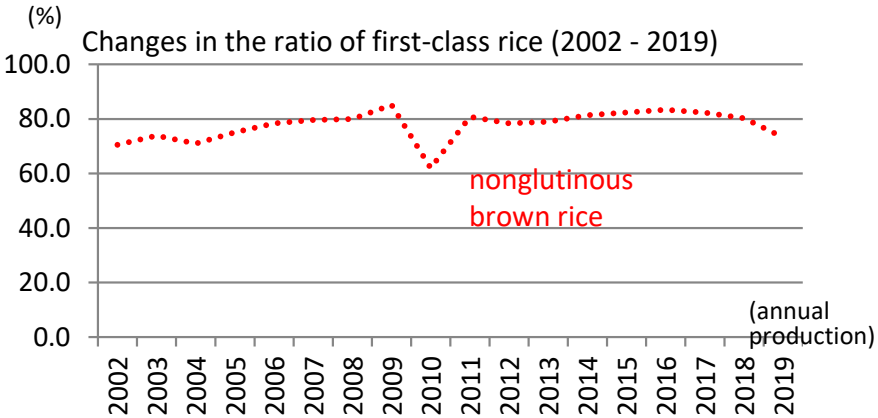
Impact

<Current status>

- ○ Deterioration in quality due to high temperature.
- ○ Yield reduction in some areas and in high temperature years.



Cross section of immature grain with white portion(left) and normal grain (right)



Note 1: Immature grains with white portion are grains that appear cloudy white due to insufficient starch accumulation. The occurrence increases when the average temperature for about 20 days after heading ~~ear~~ is 26 to 27° C or higher.

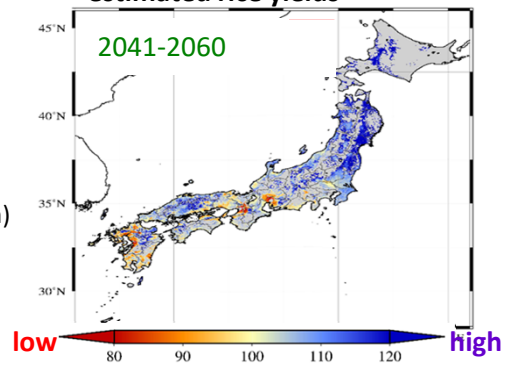
Note 2: In 2010, due to the record-breaking hot summer, immature grains with white portion occurred and the ratio of first-class rice decreased significantly.

<Future prediction>

- ○ Rice yields will increase nationally from 2061 to 2080, but will begin to decline by the end of the 21st century.
- ○ The percentage of generated milky white grain compared to the 2010s is projected to increase in the 2040s, resulting in a significant increase in economic losses due to a decrease in the area of first-class rice.

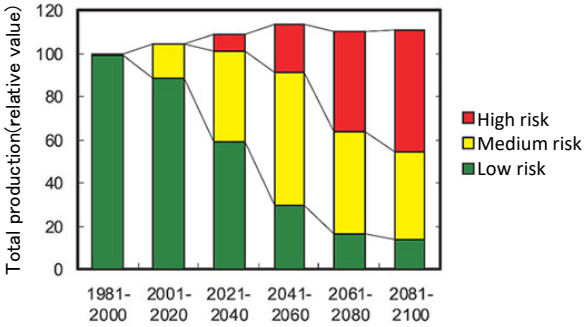
In the case of climate change scenario with large increase in temperature and CO2 concentration

1) Prediction of the distribution of estimated rice yields



(Average yield for each decade, with the average yield for 1981-2000 set at 100)

2) Prediction of national rice production and risk of quality decline



Production: Relative to the average yield of 1981-2000, which is 100.
Risk of deterioration in quality: Estimated based on the projected increase in average daily temperature after heading.

Figure: Prepared based on the "Results of Agricultural Products Inspection for Rice" by MAFF

Source: NARO

Countermeasures

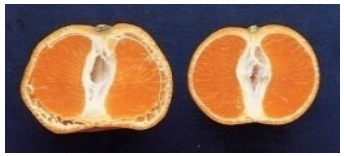
Development and dissemination of adaptation technologies	Development and disseminationof varieties
[Measures for high temperature] ○Thorough implementation of basic techniques such as manure management and water management [Pest Control] ○Thorough implementation of timely pest control, etc., using information on predicted outbreaks, etc.	[Measures for high temperature] ○Promotion of development and dissemination of high temperature resistant varieties ○Future variety development should be based on providing high temperature resistance ○Development of varieties and breeding materials with resistance to high temperature sterility

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Fruit Trees]

Impact

< Current status>

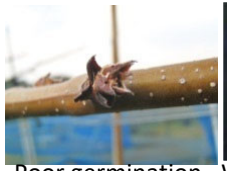
- ○Peel puffing and physiological fruit drop in citrus
- ○Poor coloring, sunburn, and fruit softening in apples
- ○Poor germination in Japanese pears, watercore in peaches, poor coloring in grapes, softening of persimmon fruit, etc.
- ○ In some areas, the suitable cultivation areas are expanding.



Peel puffing of Satsuma mandarin

Poor coloring in apples

Poor coloring in grapes



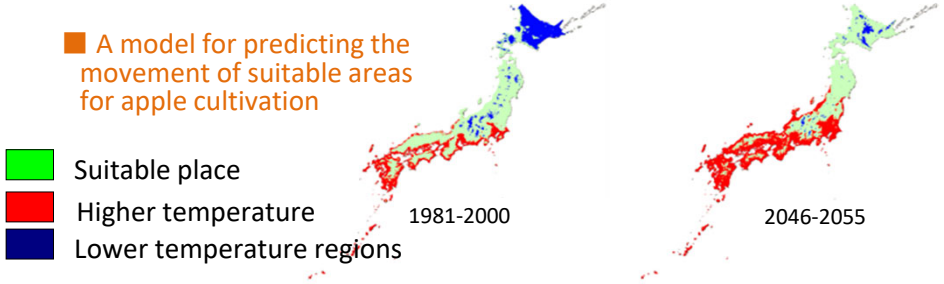
Poor germination of Japanese pear

Watercore in Japanese pear

<Future prediction>

- ○ The optimal cultivation areas for Satsuma mandarins and apples have shifted.
- ○ In grapes, peaches, sugar beets, etc., growth disorders caused by high temperature occur.
- ○ Regarding Japanese pears, there is a possibility that cultivation of varieties with high chilling requirements will become difficult in more areas.
- ○ In low temperature regions, where fruit trees have been difficult to grow, suitable areas for fruit tree cultivation have expanded.

■ A model for predicting the movement of suitable areas for apple cultivation



Source: MAFF, "Future Prospects for Adaptation to the Impacts of Climate Change" (2019).

Countermeasures

Development and disseminationof adaptation technologies

[High temperature measures}

(Mandarin Oranges)

- ○Promote the use of calcium agents, etc., to prevent Peel puffing
- ○Promoting the use of ethychlozate spraying to prevent poor coloration
- ○Promotion of cultivation management techniques such as spraying with a mixture of gibberellin and prohydrojasmon (to prevent Peel puffing) and active use of shading materials (to prevent sunburn)

(Apples)

- ○Promotion of watering and introduction of reflective sheets to prevent sunburn and poor coloration of fruits
- ○Promotion of cultivation management techniques to reduce the incidence of poor coloring and sunburn

(Grapes)

- ○Promotion of girdling, etc. as a measure against poor coloration

(Pear)

- ○Promote the introduction and dissemination of technical measures to reduce poor germination

Note: Figaron, gibberellin and prohydrojasmon are plant growth regulators.

Development and dissemination of varieties, conversion of products

[High temperature measures}

(Mandarin Oranges)

- ○Promote planting to convert to mid/late-season citrus

(Apples)

- ○Introduction of superior-colored varieties such as "Akibae"
- ○Support for cultivation demonstration utilizing elevation differences, planting for variety conversion, etc.

(Grapes)

- ○Promote the introduction of superior-colored varieties such as "Grose krone" and yellow-green varieties such as "Sunshine Muscat"

(Cross Item)

- ○Development of breeding materials adapted to high temperature conditions and breeding of the relevant varieties

[Taking advantage of opportunities}

(Subtropical and tropical fruit trees)

- ○Promote initiatives to demonstrate the introduction of atemoya, avocado, mango, lychee, etc.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Land Use Crops (Wheat, Soybeans, Tea, etc.)]

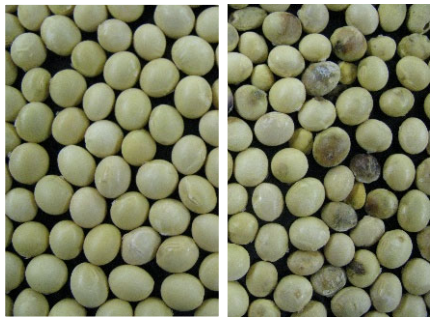
Impact

<Current status>

- ○ Delay in sowing time and advance in heading time (i.e. shortening of growing period) in wheat
- ○ Decrease in hundred grain weight, pod number, and deterioration of seed quality in soybean
- ○ Suppression of sprout growth in tea, frost damage
- ○ Increase of disease in sugar beet
- ○ Overwinter survival of unharvested potato tubers expected to volunteer potatoes

<Future-prediction>

- ○ Increase in risk of frost damage and decrease of protein content in grain in wheat
- ○ Lower yield and deterioration of grain quality in wheat (Hokkaido)
- ○ Increase of diseases and deterioration of quality in sugar beet, soybeans, red beans, and potatoes (Hokkaido)



Sucking damage to soybeans by stink bugs (The damaged soybeans are on the right.)

Deformity of tea shoots due to frost damage. (right end is normal)

Countermeasures

Development and dissemination of adaptation technologies

[Wheat and Barley]

- ○Implementation of basic technologies such as drainage and proper control of scab, etc.to reduce risks caused by high precipitation
- ○Development and dissemination of stable cultivation techniques to prevent frost damage

[Soybeans, red beans, etc.]

- ○Implementation of drainage and dissemination of Farm-oriented enhancement for aquatic system as countermeasures against high precipitation, high temperature and drought
- ○Development and dissemination of weed control technology, etc.

[Tea]

- ○Introduction of frost prevention technology using power-saving frost prevention fan systems, etc. as a measure against frost damage
- ○As drought countermeasures, control evaporation of soil water by bedding grass, etc. and implement irrigation.
- ○Demonstration and introduction of an integrated pest management system as a countermeasure against pests

[Sugar beet]

- ○Periodic monitoring of growth condition to take appropriate countermeasures against high temperature
- ○Drainage coping with high precipitation

[Potato]

- ○Prevention of overwintering of unharvested potatoes by snow plowing and snow compaction

Development and dissemination of varieties

[Wheat and Barley]

- ○Development and dissemination of varieties resistant to scab, pre-harvest sprouting, etc. as a countermeasure against high precipitation and moisture
- ○ Development and dissemination of varieties adapted to climate change to prevent frost damage

[Soybean]

- ○Development and dissemination of pest-resistant varieties

[Tea]

- ○Promote planting of varieties with resistance to pests

[Sugar beet]

- ○Dissemination of varieties with multiple disease resistance
- ○Acquirement of expertise for selecting the best variety

Pre-harvest sprouting in wheat

Damage caused by the mulberry white beetle in tea

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Horticultural Crops (Vegetables and Flowering Plants)]

Impact

< Current status>

[Open-air vegetables]

- ○ Harvest season tends to be earlier.
- ○ Increased frequency of growth disorders

[Flowering plants]

- ○ Advance or delay in flowering period, poor growth (deformed flowers, short-stemmed flowers, etc.)

[Facility vegetables and flowers]

- ○ Poor fruit set, poor growth (split fruit, poorly colored fruit, etc.) of tomatoes, etc.
- ○ Delayed flower bud differentiation in strawberry
- ○ Collapse of greenhouses due to natural disasters

<Future prediction>

[Vegetables]

- ○ In many cases, it is assumed that the cultivation of leafy and root vegetables can be continued by shifting the cultivation period.
- ○ In leafy greens such as cabbage and lettuce, early growth, the northward expansion of cultivation areas, and an increase in weight are expected.
- ○ There are concerns about the impact on fruit size and yield of fruit crops (tomatoes, bell peppers).


Fruit cracking


Poor coloring in tomatoes


Chrysanthemum normal flower


Chrysanthemum deformed flower

Countermeasures

Development and dissemination of adaptation technologies

[Open-air vegetables]

- ○ Promote adjustment of the cultivation period and timely pest control.
- ○ As a countermeasure against drought, deep tillage, application of organic matter, improvement of irrigation facilities, and use of mulch sheets to control soil moisture evaporation are promoted.
- ○ Appropriate control of spider mites, which tend to occur during droughts.

[Flowering plants]

- ○ Appropriate watering to prevent high temperature, etc.
- ○ Improvement of irrigation system, prevention of soil evaporation by mulching, etc., and timely control of pests that tend to occur during droughts.

[Facility vegetables and flowers]

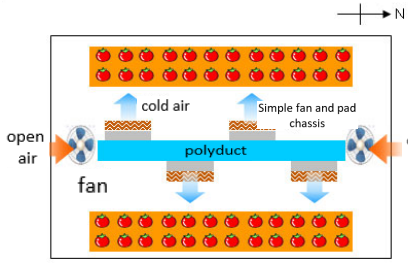
- ○ As a countermeasure against high temperature, appropriate ventilation and shading, mulching to control soil temperature, introduction of fogging system, fan and pad cooling, circulation fans, heat pump cooling, etc.
- ○ As countermeasures against natural disasters in general, introduction of disaster-resistant low-cost weatherproof greenhouses, reinforcement of pipe greenhouses, introduction of auxiliary power sources, preparing BCP, etc.


Ground temperature control mulch


Fine mist cooling


Heat pump

Simple installation of fan and pad



chassis layout

Equipment appearance and installation conditions

Development and dissemination of varieties

[Vegetables]

- ○ Development and dissemination of varieties adapted to high temperature conditions
- ○ Appropriate variety selection

[Flowering plants]

- ○ Selection of varieties adapted to high temperature conditions

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Livestock]

Impact

<Current status>

- During the summer season, the milk yield and composition of dairy cattle decline, the growth and meat quality of beef cattle, pigs and meat chickens decline, and the egg-laying rate and egg weight of egg-laying hens decline.
- Northward expansion of the habitat of arthropods such as mosquitoes and nucellus, biting midges, etc.
- In the case of forage crops, there are some reported cases of increasing annual dry matter yield in forage corn during the period 2001-2012 in parts of the Kanto region.

<Future prediction>

- Impacts on livestock growth are predicted as global warming progresses.
- In forage corn, the suitable area for double cropping is expected to expand in the 2080s.

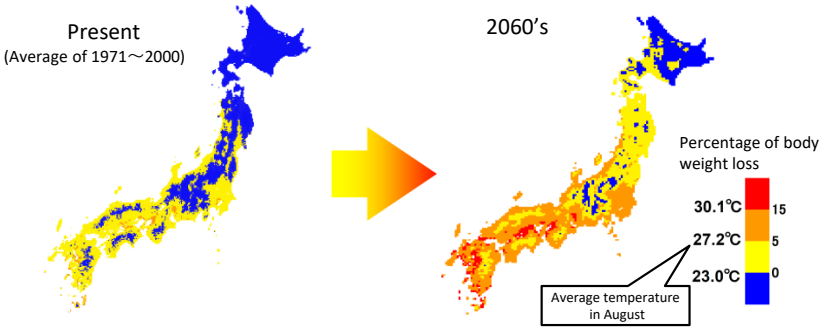
Occurrence of Global Warming Impacts in Dairy Cattle

Main phenomena	Number of reporting prefectures					Outbreak of Main cause	Main impact
	R2	R1	H30	H29	H28		
Decrease in milk yield and milk composition	17	14	14	16	15	High temperature	Decline in quality and production volume
Falling dead	12	15	17	15	14	High temperature	Decline in production
Decline in breeding performance	11	8	7	8	9	High temperature	Decline in production
Disease outbreaks	2	3	4	3	3	High temperature	Decline in quality and production volume

(Source: Crop Production Bureau, MAFF)

Forage corn

Impacts of Global Warming on Chicken Production



Source: NARO

Countermeasures

Development and dissemination of adaptation technologies

(Livestock)
[High temperature measures]

- Ensuring an appropriate livestock barn environment through the spread of heat-heat measures such as sprinkling and misting inside livestock barns, ventilation, and lime application and sprinkling of water on roofs
- Guidance and thorough implementation of appropriate feeding management techniques, such as feeding cold water and high-quality feed
- Development and dissemination of productivity-enhancing technologies, etc. to prevent the decline in body growth rate and fecundity in summer

Exhaust fan on barn wall

Lime application to barn roofs

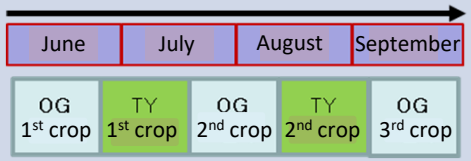
Sprinkler installation on barn roof

(Animal infectious disease)

- Review of risk management measures for arthropod-borne infectious

(Forage crops)
[Measures against high temperature and weather disasters] [Measures against pests and diseases]

- Establishment of cultivation system in response to climate change
- Development and dissemination of cultivation management technology



Examples of risk-distributed roughage production initiatives
By planting grasses with different optimal harvest times, yield reduction due to unseasonable weather is mitigated.
(OG: Orchard Grass, TY: Timothy)

Development and dissemination of varieties

(Forage crops)
[Measures against high temperature and weather disasters]

- Development and dissemination of varieties and breeding materials with heat resistance, wide ripening period, etc.

[Pest Control]

- Development and dissemination of resistant varieties and breeding materials