Strategy for Addressing Climate Change Agricultural Sector in the Korea and Research Projects of Agricultural Research Center for Climate Change

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1. Strategy for addressing climate change agricultural sector in the Korea

The Korea National Institute of Meteorological Research reported that the mean temperature in Korea peninsula had risen by 1.5 °C during the past 100 years, exceeding the global warming trend announced by IPCC. If this trend would continue, the agriculture of Korea will be affected by climate change faster than those of other regions. A total of 62 climate change-related cases affecting the agriculture area had been observed. These impacts are categorized as follows: 1) moving north of cultivation sites; 2) increase of disease, insect, and weeds due to the change of wintering environment; 3) degradation of quality and production due to reduced breeding time and early fruiting; and 4) reduction in milk and disease incidence.

The agriculture sector should develop adaptive measures to minimize the impact of climate change and should formulate strategies to mitigate greenhouse gases (N$_2$O, CH$_4$), realizing a low-carbon green agriculture.

The Rural Development Administration (RDA) of Korea plans to transform its agriculture R&D system focusing on addressing climate change and developing advanced agricultural technologies. Our basic direction is: 1) to support Korean greenhouse gas reduction initiatives through development and extension of low-carbon agricultural technologies; 2) to intensify studies to counter global warming in area such as new varieties, alternative crops, and energy-saving agricultural technologies; 3) to prevent damaged caused by disease and insect pest, and calamities, and the degradation of quality and production.

To fully utilize technological opportunities, RDA plans to develop and disseminate low-carbon agricultural technologies, research on new and renewable energy and bioenergy, develop new varieties adaptable to global warming conditions in the Korean peninsula, and explore alternative tropical crops such as mango and papaya. To minimize potential bad effects and risks, we will recalculate the suitable farming area, develop technologies to prevent or control disease, insect pest, and weeds and to mitigate disasters, and improve facilities for livestock rearing.

Korea will be obliged to reduce greenhouse gas emission from 2013. If we can develop and apply low gas-producing agricultural technologies and carbon sink, we will be able to reduce
greenhouse gases from agricultural sector by 0.6% annually until 2020, and minimize the bad effects of climate change.

2. Major research projects of ARCCC (Agricultural Research Center for Climate Change), RDA

1) Prediction of dormancy release and cold hardiness in fruit trees using phenology model

Plant cold hardiness related to dormancy enables plant to survive under low temperature. The frost damage is main factor which determines cultivation zone in fruit trees. This study was conducted to predict of dormancy release and cold hardiness for determining cultivation safety zone of major fruit trees. A thermal time-based two-step phenological model originated in Italy was applied to fruit trees for predicting dormancy release dates. Using twigs of fruit trees, controlled environment experiments were conducted to derive the model parameters: threshold temperature for chilling and chilling requirement for breaking dormancy.

As a result, threshold temperature and chilling requirement of 'Hayward' kiwi tree were 7.7°C and -100.4, respectively.

2) Evaluation of agroclimatic zone in major crops Using Digital Climate Modeling

This study was carried out to establish a spatial decision support system for evaluating climatic aspects of a given geographic location in complex terrains with respect to the quality and productivity of major crops. Monthly climate data from S6 synoptic stations across Korea were collected for 1971-2000. A digital elevation model (DEM) with a 10-m cell spacing was used to spatially interpolate daily maximum and minimum temperatures based on relevant topoclimatological models applied to Korea. For daily minimum temperature, a spatial interpolation scheme accommodating the potential influences of cold air accumulation and the temperature inversion was used. For daily maximum temperature estimation, a spatial interpolation model loaded with the overheating index
was used. Using these Digital Climate Modeling, we can make agricultural zone maps of various kinds such as Frost risk zone, phenology zone, and high quality production zone to help utilize in decision-making for site-selection of specific crop.

3) Estimation of cultivation limit zone of tropical crops by climate change scenario
The common characteristics of subtropical climatic zone move from the southward coast to the northward coast about 2071~2100 years in Korean peninsula. Global warming countermeasures need to be studied for mitigation of cultural crops, adaption and impact assessment of tropical crops. Also, it is important to estimate cultivation safety zone of newly introducing crops.

This study was conducted to estimate cultivation safety zone of tropical vegetables (artichoke, balsam pear, curcuma root, indian spinach and Molokheiya) and tropical fruit trees (mango, avocado, passion fruit, atemoya, papaya, etc.) of by climate change scenario (A1B). We classified cultivation safety zone of tropical crops based on the annual mean air temperature in the past 30 years (from 1971 to 2000) and the near future (from 2011 to 2100).

The major result in 2009 was as follows: Based on the annual mean temperature of climatology normal years (1971~2000), the safety cultivation zone for tropical crops was southward coast. But, based on the annual mean temperature of 3 climatology years (2011~2040, 2041~2070, 2071~2100), the cultivation safety zone of tropical crops will gradually move from southward to northward and area of cultivation safety zone will increase in Korea.

4) Development of agricultural drought index using precipitation and evapotranspiration

For the effective preparedness for agricultural drought, a weekly agricultural drought index was developed. It is calculated by changes in long-term water balances of water supply (effective precipitation) and water demand (evapotranspiration), calculated independently. There are good agreements among indices and drought appearances in Jeju city. The study for the accurate detection of agricultural drought with considering crop types and soil moisture, water management techniques in drought situation and spatial distribution of agricultural drought will promoting for utilization of agricultural drought indices.
The drought status on Korea in 2008 was monitored using agricultural drought indices which were developed for evaluation of agricultural water shortages with weekly terms. Firstly, weekly drought indices on 61 weather stations in Korea were calculated with computer program. Secondly, drought status in national scale was interpolated by inversed distance weighting method using ArcGIS computer program. The drought status of southern area was most severed on 40th week in 2008.

5) Establishment of crop-Weather relationship experimental fields for evaluation influence of climate change on crops in Jeju island, Korea

Global warming is considered inevitable, there is really need to conduct impact assessment of climate change on cultivated major crops, newly breeding crops, and introducing subtropical and tropical crops. Because of this reason, we created crop-weather relationship experimental fields in northern Jeju Island. These experimental fields are located on varying altitudes which are 60, 200, 370, 500, and 700 m at five regions with large pots filled up the same soil. The mean temperature condition between maximum and minimum of 5 fields differ greatly about 6 °C in annual mean temperature during the last 30 years. We have research plan about evaluation of major crops productivity and qualities by different temperature conditions, monitoring crop phenology such as dormancy depth, bud-burst, full blooming, harvesting time, and establishment of cultivation limit zone on introducing crops in these experimental fields.

6) CO₂ sink assessments for long-term monitoring in a mandarin orchard in Jeju, Korea
Long-term monitoring and accurate measuring the net ecosystem production (NEP) and the net ecosystem CO2 exchange (NEE) in a orchard ecosystems are very important to understand the carbon balance under current and future global warming environments. NEP, based on the forest ecological method, is conceptually equivalent to eddy-covariance based NEE. But NEP and NEE are methodologically independent, and they have unrelated measurement errors. Consequently, their comparison is needed to accurate estimate of forest carbon storage and to provide insight the causes of variation of annual CO2 uptake in forest ecosystems.

Our study on carbon sink assessments was based on an ecological method and Flux Measurement. We are carrying out the measurements of biomass, net primary productivity (NPP), soil CO2 efflux, and estimated the net ecosystem productivity (NEP) and the net ecosystem CO2 exchange (NEE) from 2010 in Jeju Island, Korea.