

No. 115 (October 23, 2015)

Goals and Strategies to Reduce Greenhouse Gas Emissions in the Agriculture Sector

Jeong Hakkyun, Kim Changgil

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KREI

Supervisor:	Research Director, Kim Hongsang	061-820-2236	hskim@krei.re.kr
Contents enquiries:	Senior Research Fellow, Jeong Hakkyun	061-820-2248	hak8247@krei.re.kr
Data enquiries:	Seong Jinseok	061-820-2212	jssaint@krei.re.kr

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◇ Abstract ◇

- The global community has realized mandatory reduction of GHG emissions through international conventions to cope with environmental change which can be caused by climate change.
 - The Kyoto Protocol was adopted in 1997 and the duty of reducing GHG emissions was imposed based on advanced countries by 2020.
 - In December 2015, a post-2020 new climate regime which both advanced and emerging countries participated in is expected to be established.
- Korea has also presented the goal of GHG emissions reduction by preemptively responding to international conventions.
 - The Korean government set the voluntary reduction target of 30% compared to business-as-usual (BAU) levels by 2020.
 - For a new climate regime in June this year, the government set the reduction target of 37% by 2030 compared to BAU levels; the reduction target of each sector will be determined in 2016.
- As the GHG emissions reduction target has been already assigned to the agriculture sector, strategy for reduction is being carried out. The sector has responded to setting up the reduction target for 2030.
 - The reduction target for the agriculture sector by 2020 is 1,485,000 tons, which is 5.2% compared to BAU levels. To accomplish this target, it is necessary to make efforts to address difficulties in expanding business for GHG emissions reduction initiatives.
 - The reduction goal in the agriculture sector for the year of 2030 is expected to be similar to the target for 2020 or be slightly expanded.
- Major countries such as Japan, Australia, and the U.K. have employed strategies to reduce GHG emissions in the agriculture sector.
 - Japan provides direct payment with menus for environmentally sound agriculture and aggressively promotes low-carbon agricultural and livestock products to consumers.
 - Australia and Japan create profit source for farmhouses by providing offset credits based on the emission trading system.
 - The U.K. implements biomass strategy such as promoting the treatment of animal manure by using microbes and supporting bioenergy grants.
- The GHG emissions reduction goal for 2030 in the agriculture sector needs to be determined at the level of minimizing the impact on the agriculture sector and encouraging the implementation of the low-carbon agriculture system. It is also necessary to conduct strategy continuously to achieve the GHG emissions reduction target for 2020 and 2030.
 - As core strategies to reduce GHG emissions in the agriculture sector, it is necessary to expand major businesses regarding GHG emissions reduction continuously, carry out R&D activities for developing cultivation technology to support the realization of low-carbon agriculture, implement carbon-trade reduction business by using the emission trading market, introduce the environmental mutual compliance system, broaden the consumption of low-carbon agricultural and livestock products, and establish a system for statistics, calculation, report, and verification.

1. Domestic and Overseas Trend in Response for Greenhouse Gas Emissions Reduction

☐ Trend in the global community for the convention on climate change

- After the conclusion of the UN Framework Convention on Climate Change (UNFCCC) in 1992, the global community has continuously made efforts to address climate change issues such as GHG emissions reduction to limit temperature rise below 2 degrees by the end of this century.
 - As the Kyoto Protocol was adopted in 1997 (until 2020), the duty of reducing GHG emissions was imposed on advanced countries (Annex 1, 38 countries).
 - As the amount of emissions in emerging countries such as China and India has increased, requests for expanding the duty of reduction in the global community are increasing.
- At the Durban Climate Change Conference (COP17: Conference of the Parties) in 2011, a new climate regime after 2020 as a post-Kyoto Protocol with both advanced and emerging countries was agreed to be formed.
 - At the Warsaw Climate Change Conference (COP19) in 2013, the Intended Nationally Determined Contribution (INDC) after 2020 was agreed to be submitted by 2015.
 - At the Lima Climate Change Conference (COP20) in 2014, members reached an agreement on the INDC documentation guideline and components of the new climate regime.
 - As the amount of emissions from developing countries such as China and India has increased, requests from the global community for these countries to fulfill the duty of mandatory reduction are increasing as well.

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- After the agreement is reached (Paris Climate Change Conference in December 2015), the new climate regime which will be applied to all countries from 2020 is likely to be launched.
 - The 21st United Nations Climate Change Conference is an international conference on climate change, which is expected to be held in Paris, France from November 30 to December 11, 2015.

☐ **Response by the Korean government**

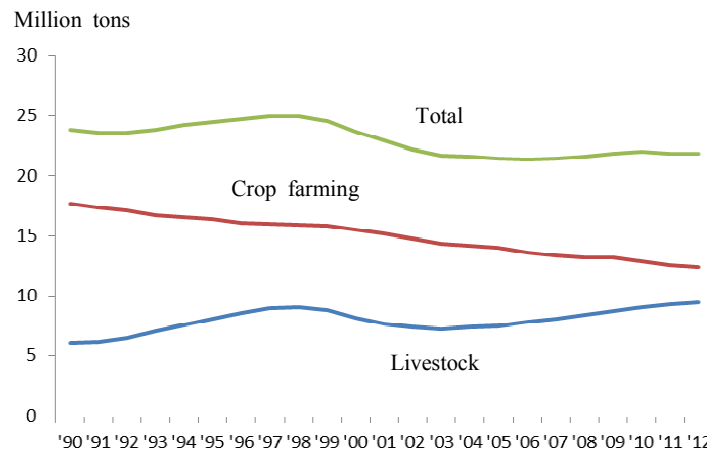
- In November 2009, the Korean government initially announced the voluntary national target of reducing GHG emissions by 2020.
 - Reduction of 30% compared to BAU levels for 2020 (776.1 million tons)
 - Preparation of laws and systems: Framework Act on Low Carbon, Green Growth (2011), Act on the Allocation and Trading of Greenhouse-Gas Emission Permits (2013)
 - Greenhouse Gas and Energy Target Management System (since 2012): A system to set and manage the reduction target for companies with a large amount of emissions
 - * As of 2014, 560 management companies are targets for reduction; among them, the number of companies in the food sector is 28.
 - Low-carbon Agricultural and Livestock Products Certification System (since 2012): A system to grant a certification mark to domestic agricultural products produced by applying low-carbon agriculture technology and enhance the production and consumption of low-carbon agricultural products by encouraging consumers to choose these products (7 companies in 2012; 31 companies in 2013; and 71 companies in 2014)
 - Emissions Trading System (since 2015): A market-based policy to encourage companies to fulfill the duty of reduction by assigning emissions allowance and operating emissions trading
 - * 525 companies as a target for trading in the 1st planned period (2015-2017)

- Process of setting the reduction target after 2020
 - From April 2014, the Korean government has organized and operated a consultative group for relevant agencies and joint task force and created a scenario for GHG emissions reduction by setting a precondition, predicting emissions, and analyzing a potential amount of reduction and economic ripple effect.
 - The estimated total of greenhouse gas (BAU: Business As Usual) which is predicted to be emitted without artificial measures is 680 million tons for 2013, 782 million tons for 2020, and 851 million tons for 2030; the total amount is expected to increase by 1.33% on annual average.
 - * Compared to BAU levels of 2009 (776.1 million tons), it has slightly increased for 2020.
 - The GHG emissions reduction target of Korea by 2030 has been fixed as 37% compared to BAU levels (851 million tons).
 - * The domestic reduction rate (25.7%p) includes reduction means which accompany financial support and expenses such as reduction of coal-fired power and introduction of a building and factory energy management system and an average vehicle fuel efficiency system and applies reduction means which need additional massive financial support and expenses such as expanding the percentage of nuclear power, adopting and commercializing carbon capture & storage (CCS), and supplying green cars.
 - * The overseas reduction rate (11.3%p) will be achieved by carrying out overseas reduction businesses, utilizing the global carbon market, and purchasing overseas trading.
 - On June 30, 2015, the "Intended Nationally Determined Contribution for Post-2020" was settled and submitted to the global community. The government will prepare a detailed implementation plan (for each year and sector/business type) for the 2030 reduction goal.

2. Goals and Policies for Greenhouse Gas Emissions Reduction in the Agriculture Sector

☐ Current status of greenhouse gas emissions in the agriculture sector

- The amount of GHG emissions in the Korean agriculture sector has slightly increased due to a decrease in the crop farming sector and an increase in the livestock sector; as of 2012, the amount of emissions from agriculture was 21.9 million tons, which accounted for 3.2% of the national amount (As of 2012, when 11 million tons of the energy sector which includes indirect emissions is considered, the percentage compared to the national amount is 4.8%).
 - The amount of emissions in the agriculture sector decreased after the maximum level was recorded in 1998; after 2007, however, it has shown a slight increase, which was caused by the increasing number of livestock and amount of chemical fertilizer use per unit area despite a decrease in cultivation areas.
 - To reduce GHG emissions in the agriculture sector, it is required to not only develop GHG emissions reduction technology but also review the adequacy of livestock breeding size and implement policy on reducing the amount of chemical fertilizer use.
 - * The agriculture and fishery sector is divided into the energy sector which covers GHG emissions by energy combustion and the non-energy sector which includes GHG emissions by non-energy emission source such as crop cultivation and livestock breeding.

Figure 1. Amount of GHG Emissions in the Agriculture Sector (1990-2012)

Source: Greenhouse Gas Inventory & Research Center of Korea (December 2014).

□ BAU (Business As Usual)

- To set the goal for GHG emissions reduction, BAU (Business As Usual) for GHG emissions needs to be first estimated. BAU is a total estimated amount of greenhouse gas which is expected to be emitted without artificial measures to reduce GHG emissions.
- The prospect for emissions in the non-energy sector of agriculture is calculated based on emission factors for each sector and activity level (cultivation size in the crop farming sector, livestock numbers in the stockbreeding sector, etc.) in accordance with the IPCC guideline.
- A reduction target is set up through two methods—setting in comparison of base year or BAU; Korea has adopted the latter. When BAU levels are calculated precisely, the amount of practicable reduction can be set accordingly.

- The amount of GHG emissions in the non-energy sector of stockbreeding increased from 9,081,000 tons in 2010 to 9,414,000 tons in 2015 and is expected to decrease to 9,195,000 tons by 2020 and 9,268,000 tons by 2030 (Table 1).

Table 1. Amount of GHG Emissions in the Non-energy Sector of Stockbreeding (2010-2050)

Unit: 1,000 tons (CO₂eq)

Classification	Enteric fermentation	Manure treatment	Total
2010	4,019	5,062	9,081
2015	4,119	5,295	9,414
2020	3,948	5,247	9,195
2025	4,013	5,350	9,363
2030	3,942	5,326	9,268

Source: Estimates by the National Institute of Animal Science (January 2015).

- The amount of GHG emissions in the non-energy sector of crop farming is expected to be on the gradual decrease from 12,882,000 tons in 2010 to 11,695,000 tons by 2020 and 11,411,000 tons by 2030 (Table 2).

Table 2. Amount of GHG Emissions in the Non-energy Sector of Crop Farming

Unit: 1,000 tons (CO₂eq)

Classification	Rice cultivation	Cropland soil	Incineration of crop residues	Total
2010	7,445	5,388	49	12,882
2015	6,570	5,535	41	12,147
2020	6,196	5,460	39	11,695
2025	5,970	5,525	38	11,533
2030	5,886	5,488	37	11,411

Source: Estimates by the National Academy of Agricultural Science (January 2015).

- BAU for the non-energy sector of agriculture is likely to slightly increase in the stockbreeding sector and decrease in the crop farming sector, which leads to 20,890,000 tons by 2020 and 20,679,000 tons by 2030 (Table 3).

Table 3. Amount of GHG Emissions in the Non-energy Agriculture Sector for Each YearUnit: 1,000 tons (CO₂eq)

Classification	Crop farming	Stockbreeding	Total
2010	12,882	9,081	21,963
2015	12,147	9,414	21,560
2020	11,695	9,195	20,890
2025	11,533	9,363	20,897
2030	11,411	9,268	20,679

□ GHG emissions reduction target

- The presented target for 2030 is 2,221,000 – 2,507,000 tons, which will slightly increase compared to the target for 2020, 1,485,000 tons (Table 4).
 - The target for 2030 will allocate share in detail, but when it comes to the average reduction rate, the non-energy sector has a low potential for reduction, which can be a barrier. For example, intermittent irrigation (irrigation in which fresh water is not maintained but water drains for a few days and land is irrigated again) is employed by most farmhouses (85.6% as a result of the Statistics Korea survey in 2012), and there is a little possibility to expand its application.

Table 4. GHG Emissions Reduction Target for the Agriculture Sector (Draft)Unit: 1,000 tons (CO₂eq)

Classification	2030 target (draft)		2020 target	
	Reduction technology	Reduction amount (1,000 tons)	Reduction technology	Reduction amount (1,000 tons)
Non-energy	Intermittent irrigation, water saving, energy facilities using livestock manure, facilities using livestock excretions as resources, high-quality forage, feed additive	702 - 988	Intermittent irrigation, reduction of chemical fertilizer use, energy facilities using livestock manure, facilities using livestock excretions as resources, high-quality forage	635

Classification	2030 target (draft)		2020 target	
	Reduction technology	Reduction amount (1,000 tons)	Reduction technology	Reduction amount (1,000 tons)
Energy	Thermal air-conditioning and heating machine, pellet boiler, multi-layered thermal screen, thermal tunnel opening and shutting installation, circulatory water film thermal system	1,519	Thermal air-conditioning and heating machine, pellet boiler, multi-layered thermal screen, thermal tunnel opening and shutting installation, circulatory water film thermal system	850
Total		2,221 - 2,507		1,485

☐ Policy on GHG emissions reduction and its diagnosis

- With preemptive responses for the international convention on climate change, the Korean government has presented the goal of reduction by 30% compared to BAU levels by 2020, and the agriculture sector also has the reduction goal of 5.2% (1.48 million tons). To achieve this goal, the agriculture sector has carried out various policies on GHG emissions reduction such as Strategy for Low-carbon Green Growth (November 2009) and the Detailed Plan for Coping with Climate Change (November 2011).
- Performances of major greenhouse gas mitigation initiatives as of 2014 (accumulative) include 7,923ha for energy-saving and new renewable energy facilities, 9 livestock manure processing facilities (generating energy), and 258kg/ha for chemical fertilizer use; when it comes to the target for 2020, however, the current level is somewhat insufficient (Table 5).
 - The results of the expert survey show that greenhouse gas mitigation initiatives have failed to achieve significant performance because of “initial high-cost investment” (33.3%) (Jeong Hakkyun and Kim Changgil, 2015). Further, decreasing income due to low yields per unit area

and difficult adaption for technology is another reason (Jeong Hakkyun, Kim Changgil and Moon Donghyun, 2014). While it is required to implement policies on supporting initial investments and income to expand greenhouse gas mitigation programs, execution of these policies seems to be insufficient.

Table 5. Goals and Performances of Major Greenhouse Gas Mitigation Initiatives (Accumulative)

Classification	Unit	Performance in 2014	Target for 2020
Energy-saving and new renewable energy facility	ha	7,923	12,425
Livestock manure treatment facility (generating energy)	site	9	30
Amount of chemical fertilizer use	kg/ha	258	188

Source: Ministry of Agriculture, Food and Rural Affairs (MAFRA).

- The Korean government has launched the low-carbon agricultural and livestock products certification system to reduce greenhouse gas. Implementing a pilot project from 2012, this certification system is to grant a certification mark to domestic agricultural products produced by applying low-carbon agriculture technology and encourage consumers to choose these products so that production-consumption of low-carbon agricultural products can be enhanced together. This initiative has reduced 300 tons of CO₂ in 2012, 1,800 tons in 2013, and 5,500 tons in 2014. Despite such performance, however, it is important to carry out promotion to shift consumer awareness for further revitalization of reduction. According to the 2014 Report on the Consumer Awareness Survey for the National Agricultural Products Certification System (Korea Agency of Education, Promotion & Information Service in Food, Agriculture, Forestry & Fisheries, 2014), the consumer awareness level for the low-carbon agricultural and livestock products certification system was merely 47.5%. Results of the expert survey have also indicated “not

having price discrimination (30.8%)” as one of the reasons for insufficient implementation of greenhouse gas mitigation initiatives (Jeong Hakkyun and Kim Changgil, 2015). Although a shift in consumer awareness for low-carbon agricultural and livestock products is required, such system and products seem to be not promoted aggressively.

- To recognize the amount of GHG emissions reduction and lead it to farm income through GHG emissions reduction projects, a system for calculation, report, and verification of the amount of emissions and reduction needs to be established. In other words, it is necessary to have basic statistical data such as statistical materials on water management methods, amounts of organic matters, applied compost, and livestock manure, and energy demand based on each farmhouse unit; currently, however, these materials are rarely established.

3. Policies on Greenhouse Gas Emissions Reduction in the Agriculture Sector of Major Countries

☐ Japan

- Japan's total amount of GHG emissions in 2011 was 1,308 million tons CO₂eq; the agriculture sector accounted for about 4.99%. Japan has the reduction target of 20% by 2030 and 80% by 2050 compared to the emissions amount in 1990.
- Policies on GHG emissions reduction in the agriculture sector by the Japanese government include promotion of eco-friendly agriculture and optimization of fertilizer use, implementation of "CO₂ marking" and "direct support grants for environmentally sound agriculture," provision of offset credits in connection with the emission trading system, projects for supporting the introduction of low-carbon facilities (supplying a plant factory, adopting LED), development of technology for methane emissions reduction, introduction of heating pumps in temperature-adding facilities and multi-layered coating, and promotion of "local production for local consumption."
 - Initiatives to provide direct grants for supporting environmentally sound agriculture include projects of reducing the use of chemical fertilizer and pesticide by 50%, combining cultivation of cover crops, living mulches or plants and fresh water management during winter, and conducting organic farming.

☐ Australia

- The percentage of the agriculture sector in the amount of GHG emissions from Australia in 2012 was 15%. The country has the reduction target of 60% by 2050 for the emissions amount in 2000.

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- Australia's policies on GHG emissions reduction for the agriculture sector include cutting emissions from agriculture systems, improving energy efficiency in the agricultural sector, promoting alternatives of using fossil fuels, expanding the opportunity of biological immobilization of greenhouse gas, guaranteeing efficiency in R&D investment for GHG emissions reduction, and providing the agriculture sector with carbon-offset credit in compliance with the Kyoto Protocol and voluntary carbon-offset credit under the Carbon Pollution Reduction Scheme (CPRS).

☐ **U.K.**

- The agriculture sector accounts about 9% of the total GHG emissions in 2010, 590 million tons CO₂eq. The U.K. government has the reduction target of 50% by 2027 and 80% by 2050 for the 1990's level.
- The U.K. government has employed GHG emissions reduction strategy based on the Climate Change Bill in 2008 and the UK Low Carbon Transition Plan in 2009. Relevant policies include biomass strategy of promoting livestock manure treatment using microbes and supporting bioenergy grants and utilizing an integrated package for water pollution and reducing indirect greenhouse gas (N₂O) as nitrogen-sensitive area agricultural programs. IPPC regulations include control of environmental impacts by producers of pigs and poultry and reduction of indirect GHG emissions. In addition, the country implements the Good Agricultural Practices (GAP).

☐ **Implications of cases from major countries**

- The Korean government is also able to promote organic agriculture and extensive agriculture and reduce livestock numbers and use of nitrogen

fertilizers by providing direct payment for environmentally sound agriculture.

- Provision of offsetting credits based on the emission trading system can lead to generating profit source for farmhouses and presenting a win-win growth model between companies and agriculture.
- Active promotion of low-carbon agricultural and livestock products to consumers can ensure price discrimination and expand low-carbon farming.

4. Strategies to Reduce Greenhouse Gas Emissions in the Agriculture Sector

☐ **Basic direction for setting the 2030 reduction target in the agriculture sector and its response**

- The target for GHG emissions reduction in each sector for the year of 2030 is expected to be set by consultation between government agencies in 2016.
 - When it comes to the basic direction for setting the reduction target and response, the agriculture sector needs to set the goal on the basis of scientific analysis results such as estimation of potential reduction as well as at the level of minimizing the impact on the sector, presenting a long-term vision for accelerating the implementation of a low-carbon agricultural system, and ensuring stable investment and execution of new low-carbon reduction means.
- Strategies are continuously employed to accomplish the 2030 reduction target effectively, which is expected to be similar to or increase slightly from the 2020 reduction target (1,485,000 tons / 5.2% compared to BAU levels).
 - Not limiting to the current application of greenhouse gas reduction technology, but broadening reduction potential by developing technology
 - As for greenhouse gas reduction policy, establishing major goals and detailed plans for each period with a long-term perspective
 - Developing policy programs in connection with the creation of farm income and implementing these programs as core initiatives with the aim of inducing engagement of farmers and achieving tangible performance

- Enhancing cooperation with consumers to reduce GHG emissions by highlighting an eco-friendly image of the agriculture sector
- Sharing a proper role for each relevant player and establishing the network to enforce efficient policy on GHG emissions reduction

□ Continuous expansion of major projects regarding GHG emissions reduction

- Expanding the supply of reduction technology such as water management for rice paddies and improvement of enteric fermentation
 - According to the results of the expert survey for rice paddy water management, using labor force at farms without an inlet for irrigation leads to a high level of possibility of on-site application and cost effectiveness. In that sense, more aggressive promotion and training are needed to ensure rice paddy water management with using manpower by farmhouses. For paddies with well-organized waterways, intermittent irrigation requires labor time of about three hours. Further, water needs to be supplied again one week after water is drained. To induce medium drainage, training items for intermittent irrigation are included in farming technology training programs in January to February based on agricultural technology centers in cities and counties which have paddies with well-arranged waterways. Such items can include intermittent irrigation's impact on the farming environment (GHG emissions reduction, climate change mitigation, etc.) and rice productivity such as maintaining the vitality of roots and enhancing resistance to lodging (Jeong Hakkyun et al., 2014).
- Increasing installment of facilities for generating energy and joint resources from livestock manure
 - Results of the expert survey for livestock manure resource facilities have shown a high level of possibility of on-site application; in terms of a project for creating energy and joint resources from

livestock manure , however, high expenses are invested at the initial stage with much burden of local expenses, which are barriers to expansion. Under these circumstances, it is necessary to lower installment expenses continuously through technology development and improve support conditions by stages such as mitigation of burden to pay local expenses. As it is important to sell high-quality liquefied fertilizer to farmhouses according to the calculation of economic effects of biogas plants, more concrete plans for enforcement need to be sought (Jeong Hakkyun et al., 2014).

- Expanding the use of new renewable energy and supply of energy-saving facilities
 - Geothermal heat pumps as new renewable energy and multi-layered thermal screen as an energy-saving facility have a low level of marginal abatement cost (Kim Changgil et al., 2011). When it comes to the possibility of on-site application and cost effectiveness, multi-layered thermal screen was ranked as the top according to the expert survey (Jeong Hakkyun and Kim Changgil, 2015).
 - As for technology utilizing new renewable energy, the price of thermal heat pumps and wood pellets is high; even if they are supplied by the central and local governments, farmhouses have a relatively high level of burden despite expenses with 20% of self-payment. Under these circumstances, actual expansion of supply has not been successfully carried out unlike the expectation. Therefore, it is necessary to review lowering the self-payment percentage of farmhouses and expansion of financing in the mid and long term. Further, production facilities such as geothermal heat pumps and wood pellet heaters need to be increased in size so that production cost can be reduced. A massive size of private investment needs to be achieved to ensure an increased size of production facilities; however, it is highly unlikely to secure private investment due to various risks, which can be eased by Green

Insurance (Kim Changgil et al., 2010). In addition, private investment can be attracted by tax-exempt bonds. Without taxes on interest earnings of a person who purchases bonds of a company which produces low-carbon facilities, tax-exempt bonds motivate consumers to purchase bonds and encourage companies to invest in increasing the size of low-carbon facilities with funds from selling bonds.

* “Green Insurance” refers to an insurance product which covers risks regarding the green industry or includes eco-friendly content.

□ R&D activities such as developing cultivation technology to support the realization of low-carbon agriculture

- According to the results of the expert survey, the rate of responses from experts who said that development and dissemination of reduction technology are needed is the highest (44.4%) to apply and spread the technology (Jeong Hakkyun and Kim Changgil, 2015).
- It is necessary to develop climate smart agriculture technology which can not only reduce GHG emissions but also raise productivity and achieve adaptation to climate change.
- The investment environment needs to be created so that research facilities are directly supported or private companies can make an investment in research and development.
 - With the development of the national unique emission coefficient for the agriculture sector, the statistical basis for calculating the amount of emissions needs to be improved to the level of advanced countries.
 - Development of technology for producing low-carbon agricultural products includes developing a manual for each low-carbon production and cultivation technology of food crops, methane reduction technology

for livestock enteric fermentation by utilizing BT, soil management technology for enhancing soil carbon, a purification system to improve the efficiency of livestock manure treatment and biogas production, and digester operation technology, improving preconditioning procedure, diversifying heat sources in the sector of developing new renewable energy use technology, and improving the performance of heat pumps.

☐ **Carbon trade-based reduction project by using the emission trading market**

- KRX Emission Trading Market was launched on January 12, 2015. The Ministry of Environment has enforced a system for offsetting external reduction businesses to promote the emission trading system (Paragraph 1, Article 8 of the Act on the Allocation and Trading of Greenhouse-gas Emission Permits).
- It is necessary to have opportunity factors for generating farm income by turning the reduced amount of GHG emissions in the agriculture sector into credits and trading them in the emission trading market.
 - The emissions reduction project for enterprise participation needs to be sought. In pursuit of mutual cooperation between companies and rural areas, this project allows companies to pay expenses necessary for introducing low-carbon farming technology and utilize reduction performance.
 - It is a key issue to calculate and record the reduced amount of emissions and make credits based on materials for estimation and verification.

☐ **Seeking measures to adopt the environmental cross-compliance (ECC) by the EU**

- The EU's agricultural and environmental program, which was reviewed by the Ministry of Agriculture, Food and Rural Affairs (MAFRA), employs the concept of environmental cross-compliance (ECC). If such a program is launched in Korea, various alternatives of farming technology to expand low-carbon agriculture can be included in the program.
- Practical alternatives for agriculture technology under the enforcement of the agricultural and environmental program can support farms which conduct intermittent irrigation, no-till farming, or soil carbon accumulation technology and cultivate green manure crops during winter.

☐ **Expanding the consumption of low-carbon agricultural and livestock products**

- Introduction of the low-carbon agricultural and livestock products certification system
 - Calculating the amount of GHG emissions reduction for the entire process of producing agricultural and livestock products
 - A system to grant a certification mark to domestic agricultural products produced by applying low-carbon agriculture technology and enhance production and consumption of low-carbon agricultural products by allowing consumers to choose these products
 - Expected to save management expenses thanks to consulting for energy use of farms and pioneering sales channels and increasing sales by promoting low-carbon agricultural and livestock products

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- Need to vitalize consumption of low-carbon agricultural and livestock products further to promote farmers to accept low-carbon agriculture technology
 - The ratio of responses remarking “not having price discrimination due to the low awareness level of low-carbon agricultural products” was second highest (24.6%), following “decreasing amount per about 1,000 m² (25.7%) (Kim Changgil et al., 2012).”
 - Low-carbon agricultural and livestock products are safe and high-quality agricultural products which are produced by farms contributing to mitigating climate change. Sufficient promotion of low-carbon agricultural and livestock products will encourage many consumers to purchase the products with interest.
 - Preparing promotion by prior consultation with department stores and large supermarkets
 - Connecting carbon labeling (low-carbon certification) and allowing processed food whose raw ingredients are low-carbon certified agricultural and livestock products to acquire carbon labeling (low-carbon certification) more easily
 - Expanding a measure to link with the carbon point system so that consumers can accumulate carbon points by purchasing low-carbon agricultural and livestock products

□ Establishing statistical data and calculation/report/verification system

- It is imperative to establish a calculation/report/verification system for the amount of emissions and reduction to recognize the amount of GHG emissions reduction and connect the amount to farm income.
 - Need to have objective evidential materials and quantification and establish a system to allow a third party to verify the amount

- Establishing various statistical data having an impact on greenhouse gas emission and securing reliability
 - Statistical data on water management methods for each year, amount of organic matters and fertilizer use, amount of livestock manure, energy demand for each farm unit, etc.
 - It is urgently needed to establish activity materials on the input of chemical fertilizer with paddies and fields separated.

KREI Agricultural Policy Focus No. 115

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Emissions in the Agriculture Sector

Registration No. 6-0007 (May 25, 1979)

Printed October 23, 2015

Published October 23, 2015

Publisher Choi Sei-kyun

Operation committee Kim Hong-sang, Kim Byung-ryul,
Park Joon-kee, Seong Joo-in,
Woo Byung-joon, Moon Han-pil

Publishing institution KREI

601, Bitgaram-ro, Naju-si, Jeollanam-do,
58217, Korea

1833-5500 <http://www.krei.re.kr>

Printed by The Disabled's Products Sales Support
Association

+82-2-2269-5523 dec5523@hanmail.net

ISBN: 978-89-6013-782-0 93520

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