

Trends in Research and Development of High-quality Domestically Produced Wheat

Daisuke KANAMA
Affiliated Fellow

Yoshihiko SUMI
Affiliated Fellow

1 Introduction: Current State Wheat Production and Consumption in Japan

According to the Family Income and Expenditure Survey conducted by the Statistics Bureau of the Ministry of Internal Affairs and Communications, a Japanese household with two or more people consumes 86kg of rice, 45kg of bread, and 36kg of noodles annually^[1] (these are three major staple foods for the Japanese). The food self-sufficiency rate for rice has increased from 95% to almost 100%, but

the rate for wheat, a main ingredient for bread and noodles, is extremely low at about 13%. In particular, the rate for bread wheat is only 1%. The remaining 99% depends on imported wheat.

Of the total of imported wheat, about 50% come from the United States, and the rest come from Australia and Canada^[2,3] (Table 1). Most of the wheat from the United States and Canada is used for bread and ramen noodles, and most of the wheat from Australia is used for udon noodles. Representative products include Dark Northern Spring wheat (from the United States), Western Red Spring wheat (Canada), and Standard White wheat (Australia). The

Table 1 : Import and Production of Wheat by Japan in 2009

Countries of production	Volume (10,000 tons)	Percentage
Total of imported wheat	480	86.8%
United States	296	53.5%
Australia	96	17.4%
Canada	88	15.9%
Total of domestically produced wheat	73	13.2%

Prepared by the STFC based on reference^[2,3]

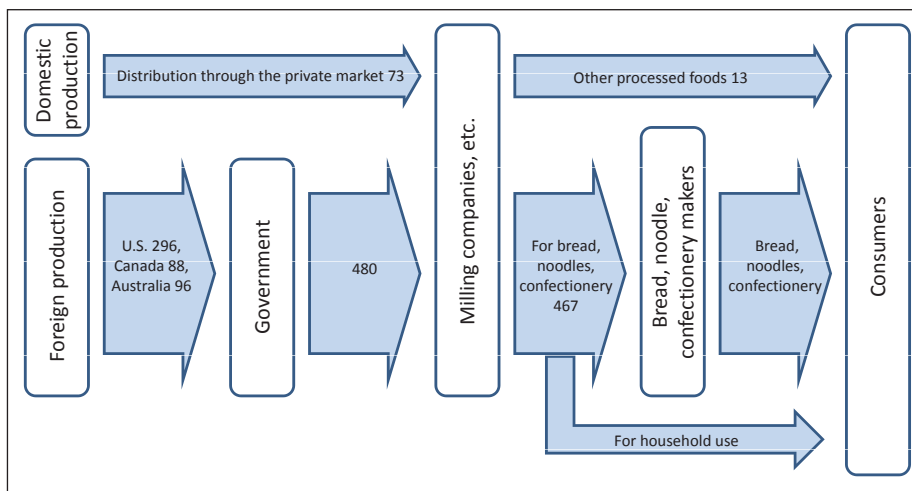


Figure 1 : Outline of Wheat Distribution and Volume (10,000 tons)

Prepared by the STFC based on reference^[2,3]

government buys all imported wheat, adds a markup (profit margin), and sells it to milling companies and others. The wheat is then processed into bread, noodles, etc. and delivered to consumers^[2,3] (Figure 1).

Along with rice and corn, wheat is one of the most produced crops in the world. However, in Japan, strong wheat varieties (for bread and ramen noodles) are hardly cultivated. Mostly, medium wheat varieties (for udon noodles and confectionery) are cultivated^[4] (Figure 2). This is because most domestically grown wheat varieties (for udon noodles) have been modified to suit Japan’s humid climate and food culture since the Yayoi period (an Iron Age era), and other wheat varieties that are suitable to dry regions are difficult to cultivate since, in rainy Japan, they tend to suffer or their seeds sprout before harvesting.

However, demand is growing for bread and ramen noodles made from domestically produced wheat. This is attributable not only to the growing need for a variety of foods but also to anxiety surrounding imported foods, a desire to improve the food self-sufficiency rate, and (due to the increase in the

population of wealthy people in emerging countries and climate change) rising and destabilized wheat prices.

This article discusses changes in wheat production around the world as well as expectations for domestically produced wheat and trends in research and development in Japan. It also examines the direction for the development of domestically produced wheat. Wheat is categorized into strong, medium, and weak flour depending on protein contents (Table 2), and this article focuses on strong wheat, the production of which is extremely low but the demand is high.

Incidentally, in terms of domestically produced bread and other products, attention has been drawn to rice bread and rice noodles. However, this article does not discuss these products because the taste and texture are different from wheat-based products as well as because it is expected to take substantial time for the industry to become large-scale.

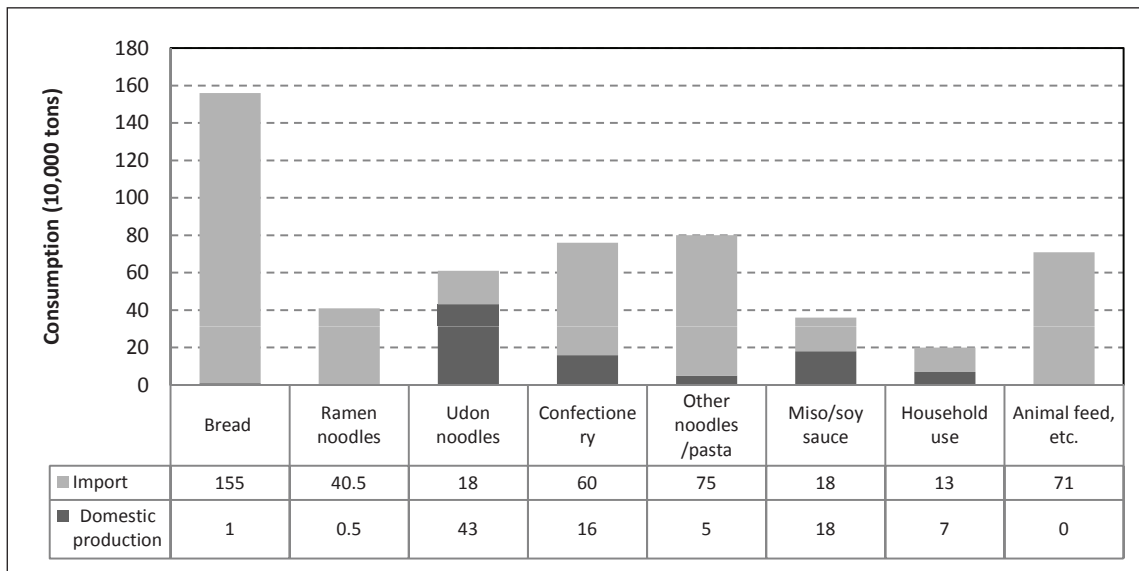


Figure 2 : Self-sufficiency Rates for Wheat by Use

Prepared by the STFC based on reference^[4]

Table 2 : Wheat Varieties, Characteristics, and Protein Contents

	Weak flour	Medium flour	Strong flour
Protein content	6–9%	9–11%	11–13%
Gluten quality	Weak	<<<<	Strong, stretchy
Kneading	Less kneading	Regular kneading	More kneading
Major uses	Castella (sponge cake), Cake, Japanese confectionery, Biscuit, Tempura flour	Instant noodles, Udon noodles, Biscuit, Japanese confectionery	White bread, Sweet bun, French loaf, Bread crumbs, Ramen noodles
Major wheat varieties imported to Japan	Western White (WW) from the U.S.A.	Standard White (ASW) from Australia	Western Red Spring (1GW) from Canada, Dark Northern Spring (DNS) from the U.S.A.

Prepared by the STFC based on reference^[2,3]

2 | World Wheat Production and Consumption

2-1 Concentrated Wheat Growing Regions and World Wheat Imports

Wheat has long been improved worldwide to adapt to relatively cold and dry climates. Japan has hot and humid weather during the harvesting season for wheat (around June and July), and so diseases such as wheat yellow mosaic virus, Fusarium head blight, and pre-harvest sprouting occur often, making harvesting impossible. In particular, strong wheat varieties used for bread and ramen noodles (which are in high demand in Japan) have these tendencies. Therefore, Japan depends on imports for strong wheat.

Of course, these characteristics make other regions in the world with hot and humid climates difficult places to cultivate wheat. Therefore, wheat-growing regions are heavily concentrated in parts of the world that have adequately fertile land, that have a small amount of rain during the harvesting season, and that are suitable for large-scale farming. Figure 3 (left pie chart) illustrates world wheat output between 2009 and 2010, and the top eight producers including the EU (the largest producer) and Canada (the eighth) produce 78% of world wheat^[5,6].

The populations who eat wheat as a staple food do not necessarily live in the wheat-growing regions. As such, many countries import wheat from a small number of wheat-producing countries. During the 2009–2010 period, the amount of wheat imported by the top 26 importing countries combined is still less than 70% of the total amount of wheat imported worldwide (Figure 3, right pie chart). This means that

countries are competing to acquire wheat.

As discussed, wheat-producing countries and wheat-consuming countries are substantially different. Countries that have large populations and are located mostly in the monsoon, tropical, or excessively dry regions (which are not suitable for wheat cultivation) in, for example, Southeast Asia, Africa, and the Middle East, heavily depend on countries like the United States, the European Union countries, Russia, Australia, and Canada, which have small populations relative to their wheat production and have high production technology. If these producing countries limit their wheat exports, many importing countries will immediately run short of wheat, and prices will skyrocket. It is also expected that the populations in the wheat exporting countries will increase.

2-2 Rise in Demand for Cereals Due to the Increase in the Population of Wealthy People

The world consumption of cereals (including wheat) is expected to increase during the twelve years between 2008 and 2020 by 500 million tons to reach 2.7 billion tons^[7]. In contrast, cereal production is expected to remain at 2.65 billion tons in 2020. So the ratio of cereal carryover stocks to utilization is expected to drop from about 20% in 2008 to 15% in 2020, lower than the food security indicator (17–18%) set by the Food and Agriculture Organization of the United Nations. Therefore, all cereal prices are expected to trend upward. Wheat is no exception, and in 2020, nominal wheat prices are projected to rise to a level comparable to the highest price recorded in 2008. These are about three times higher than the prices in 2000, the previous base year^[7].

The underlying reason for the rises in cereal

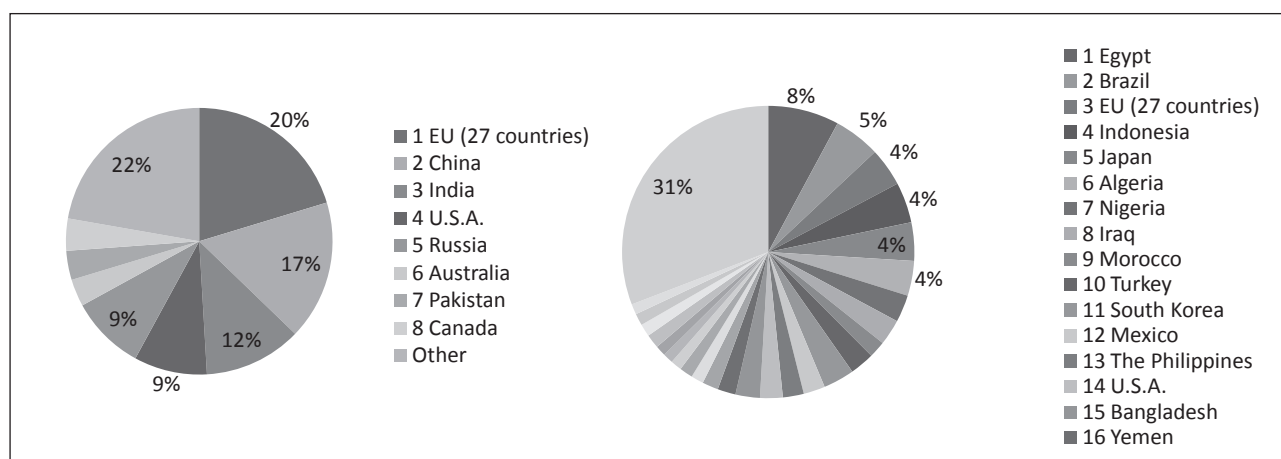


Figure 3 : World Wheat Growing Countries (Left) and Importing Countries (Right) between 2009 and 2010
Prepared by the STFC based on Reference^[5,6]

prices and the tight supply and demand situation is the increase in the population of wealthy people in emerging countries. Despite the impact of the stagnant world economy following the financial crisis in developed countries and elsewhere, emerging countries' economies continue to grow at a high pace and are likely to lead the world economy. As these countries become richer, their meat consumption increases, and so more cereals will be needed for animal feed. In addition, the consumption of processed wheat foods, including bread and noodles/pasta, is likely to increase. As a result, China and India may become importers even though their wheat self-sufficiency rates are now close to 100%. There is a concern that this may also have a heavy impact on the wheat market.

Moreover, cereal consumption in other Asian countries, Africa, and the Middle East is projected to increase rapidly. Cereal production in these regions has been increasing, but the demand is growing at a faster pace, and so the dependence on imports is also growing every year. Among some of the top importers of wheat, including Egypt, Indonesia, Nigeria, and Bangladesh, the volumes of imports have already increased in the past five years. In particular, cereal consumption in Africa is expected to reach about 270 million tons (10% of the world consumption) in 2020 due to a substantial increase in the population and economic growth^[5]. In contrast, production is not likely to catch up with demand, and so, in 2020, Africa is projected to expand its imports of cereals to 80 million tons, twelve times larger than in 1996.

2-3 Instability in Production Due to Climate Change

The recent abnormal weather has spurred the global competition for cereals. In 2010, more than ten countries limited their exports of wheat due to poor harvests caused by abnormal weather.

Russia is the world's fourth largest wheat producer (about 9% of the world's share in 2009) and the world's fourth largest wheat exporter (about 14% of the world's share in 2009). However, in 2010 Russia announced a ban on exports of wheat and other cereals between August 15 and the end of December. This action was taken to prioritize domestic supply because about 20% of the wheat planted in fiscal 2010 was damaged and not harvested due to drought.

Wheat exports are usually concentrated in the latter half of the fiscal year due to seasonal factors. If we suppose that half of Russia's exports vanished from seaborne trade, 7% of the world's annual exports would have disappeared. In addition, Ukraine and other neighboring countries were also affected by similar drought conditions.

Australia announced that only half of the wheat cultivated in 2010 would be able to be used for flour due to its inferior quality caused by that year's floods. Standard White (ASW) from Australia is used for udon noodles in Japan, and there is concern that the Japanese market may be directly affected.

There is also concern that farmland may decrease worldwide. Currently, deserts are increasing globally by five million hectares annually. This is equivalent to Japan's total farmland (4.65 million hectares). Moreover, increasing urbanization and water shortage may make it difficult to increase farmland globally.

In response to this situation, Korea announced that it secured 2.1 million hectares of farmland in Sudan. China also secured 2.8 million hectares in Congo and 2 million hectares in Zambia. Additionally, Saudi Arabia and the United Arab Emirates are trying to secure farmland abroad in exchange for oil. Japan has historically protected domestic farmers and currently does not aim to secure inexpensive farmland overseas.

Due to the recent situation, the international wheat prices rose about three times higher compared to 2000 or roughly doubled from 2006. Expecting that the prices will continue to rise in the long term, investors have been pouring speculative money into the market, which is also considered to have spurred the price hikes. The impact of climate change, unlike the increase in the population of wealthy people, is difficult to predict and makes wheat prices unstable.

3 | Outlook for Domestically Produced Wheat

3-1 Consumers' Expectations for Domestically Produced Wheat

In response to the recent global trends, wheat prices are also rising in Japan. Currently, the Japanese government imports all wheat and determines the selling prices to milling companies and others. In recent years, the prices have gone up dramatically: by 10% in October 2007 and by 30% in April 2008.

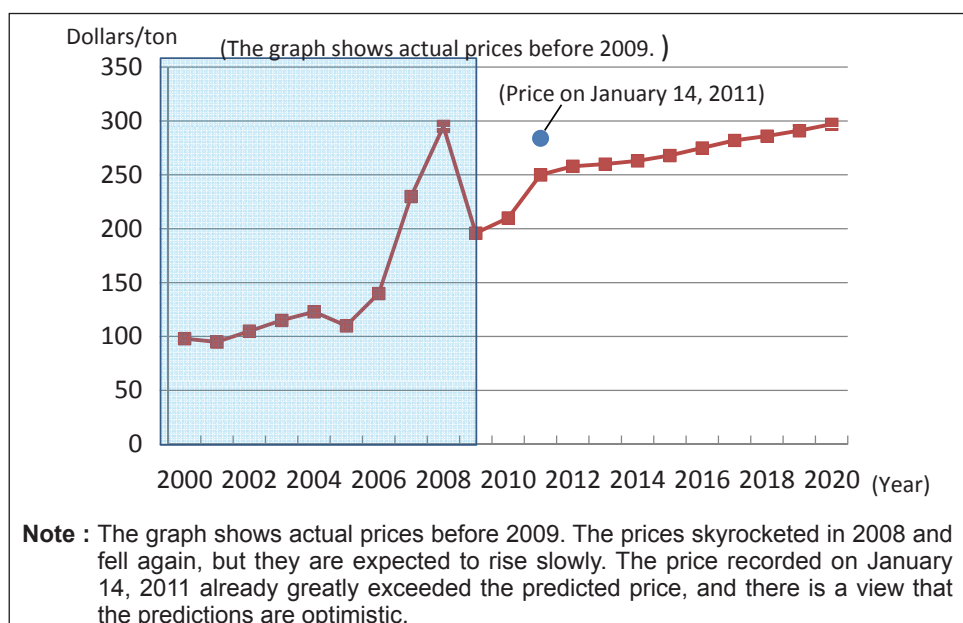


Figure 4 : International Wheat Prices (Nominal) and Their Prospects

Source: Reference^[9]

The Ministry of Agriculture, Forestry and Fisheries has just raised the selling prices of imported wheat to milling companies by 18% on April 1, 2011 on the ground that international prices of wheat continue to rise substantially. In response, major baking companies have raised the prices of their main products by 5–10%.

Amid concerns over global competition for cereals, the demand for domestically produced wheat has been growing in Japan. Enhanced awareness for food safety is a major factor. For domestically produced wheat, agricultural chemicals are used, but not post-harvest chemicals. The impact of agricultural chemicals on human health is not yet very clear. However, there is a new and growing inclination among consumers to pay more for locally-grown, safer food. Some major turning points for this change in values are the two cases that occurred in China in 2008: 1) dumpling poisoning and 2) a contaminated formula that harmed the health of 300,000 infants.

The number of consumers who are interested in domestically produced wheat and the number of bakeries that are conscious about safety have been increasing. The Japanese government imports a substantial amount of wheat that is cultivated in large-scale farms, and most of the wheat is processed into bread, ramen noodles, pasta, etc. before it is provided to consumers. As such, consumers had not paid much attention to different varieties, compared to rice. However, demand for good-quality domestically produced wheat is growing as the awareness of local

production for local consumption grows and as, due to improved baking technology, more people make homemade bread and the number of bakeries increases. In addition, consumers have gradually begun to pay attention to wheat varieties and where they come from^[8].

We conducted a small-scale market survey in front of a bakery in Sapporo city in January 2011 (Figure 5). The bakery uses both imported and domestically produced wheat for their bread. Thirty-two people who bought bread at the shop responded to the survey and were asked “Even though domestically produced wheat is more expensive, how much more are you willing to pay?” The respondents answered that they would pay up to 2.3 times more on average.

However, while the demand for domestically produced wheat has been growing, domestic wheat production has not changed much in the past several years. Figure 6 illustrates changes in bid prices for wheat in Japan. Haruyokoi is the highest priced and is a representative domestic strong wheat variety used for bread. The price for Haruyokoi is about two times higher than imported varieties used for bread. Changes over the years show that the trading price of Haruyokoi has been increasing, indicating higher demand for domestically produced wheat. To fill the price gap, the Ministry of Agriculture, Forestry and Fisheries buys all imported wheat, adds a markup (profit margin), and sells it on the market. By raising the price of imported wheat, the government uses the profits to provide subsidies to those who buy domestic

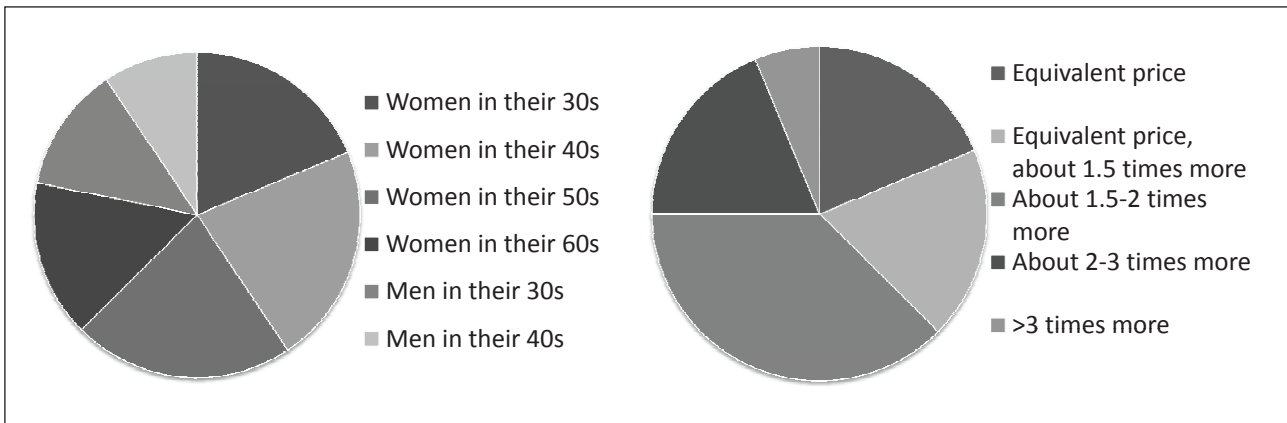
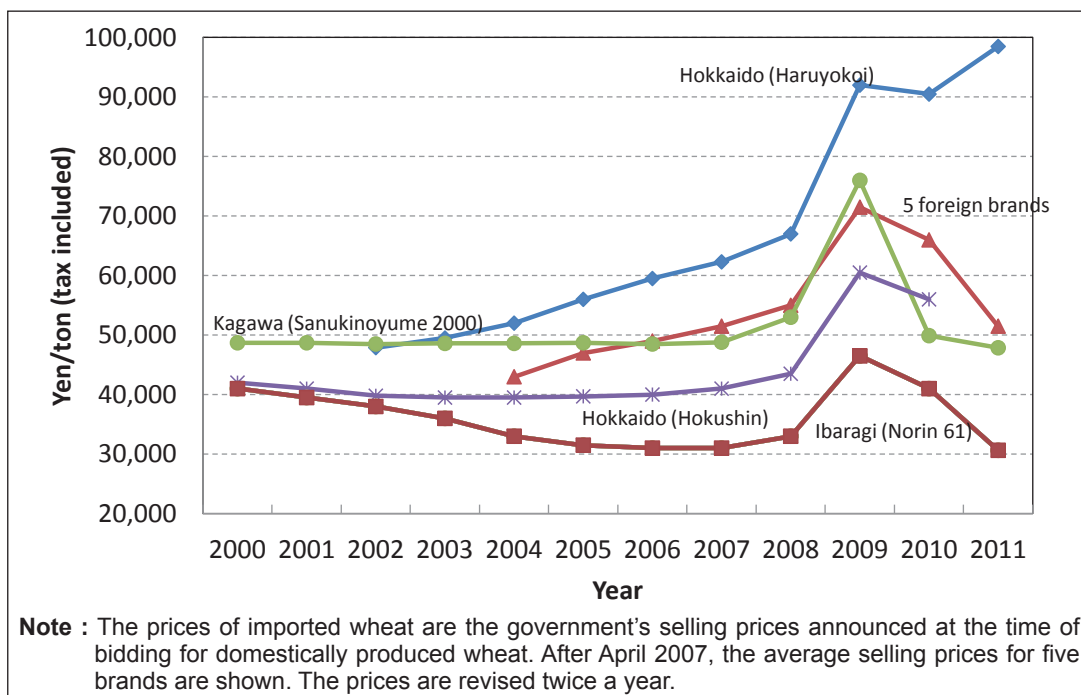


Figure 5 : Survey Results Regarding Buying Motivation for Bread Made from Domestically Produced Wheat: Ages and gender of the respondents (left); Answers to the question, “Even though domestically produced wheat is more expensive, how much more are you willing to pay?” (right)

Source: Reference^[8]



Note : The prices of imported wheat are the government’s selling prices announced at the time of bidding for domestically produced wheat. After April 2007, the average selling prices for five brands are shown. The prices are revised twice a year.

Figure 6 : Changes in Bid Prices of Wheat in Japan by Major Production Region (Brand)
Prepared by the STFC based on reference^[3]

brands to help them buy domestically produced wheat.

3-2 Food Security

In Japan, Article 2, paragraphs 2 and 4 of the Food, Agriculture and Rural Areas Basic Act stipulate the following regarding food security. They also directly apply to domestically produced wheat.

(Article 2, paragraph 2) In consideration of the fact that the world's food supply and demand and trade have some uncertainties, stable food supply to the citizens shall be secured by increased domestic agricultural production as a base together with appropriate combination of import and reserve.

(Article 2, paragraph 4) Even in the case when the domestic food supply and demand get stringent or likely to be so for a considerable period of time due to poor harvest or interrupted imports, the minimum food supply shall be secured so that no significant adverse effect is generated to the stable life of the citizens and smooth operation of national economy.

As discussed earlier, wheat is used to make bread and noodles and, along with rice, is a staple food for the Japanese. The global supply and demand of wheat has been unstable due to increasing populations in emerging countries and frequent occurrences of abnormal weather. The situation is clearly a threat to food security in Japan. Therefore, domestic wheat

production shall be increased (Article 2, paragraph 2), and the wheat supply shall be secured to avoid significant adverse effects to the national economy (Article 2, paragraph 4).

Regarding food security, Article 2, paragraph 1 of the same act also stipulates that a stable supply of high-quality food at reasonable prices shall be secured for the future, not only to prepare for unforeseen circumstances but also to maintain the basis for healthy and fulfilling lives (Article 2, paragraph 1).

As such, it is necessary to develop good-quality domestic wheat varieties comparable to imported wheat and to improve product development technologies, such as for the cultivation of new varieties, processing, milling, and bread- and noodle-making.

4 Policy Surrounding Domestically Produced Wheat and Trends in Research and Development

4-1 Changes in Agricultural Policy Surrounding Domestically Produced Wheat

Wheat production in Japan was stagnant until the 1970s. However, since wheat was positioned as one of the alternative crops to cultivate in rice fields, its production has been gradually increasing. The new wheat policy outline published in 1998 suggests a policy to cultivate wheat as a main crop in rice fields, and projects to develop new technologies have been gradually accelerating^[9].

To improve research and development on wheat and barley, the policy outline suggests the following: reflecting the requests from producers and users into variety development; clarifying targets to promote variety development; facilitating the transfer of research results; and establishing an urgent research and development project. In 1999, the urgent development project concerning new wheat and barley varieties launched. Research continued as a project related to domestically produced wheat, and cultivar improvement and technological development were conducted. For example, Nishinokaori, Kitanokaori, and other strong wheat varieties were cultivated to adapt to different regional environments, and their qualities for milling, baking, and processing were studied^[10].

The Integrated Research for Providing Fresh and Delicious “Brand Nippon” Agricultural Products,

which launched in 2003, aimed to address pre-harvest sprouting and Fusarium head blight, to study reasons for low quality, and to develop new uses in order to expand the demand. Against hard-to-control diseases such as pre-harvest sprouting, Fusarium head blight, and wheat yellow mosaic virus, resistant genes were introduced, integrated technology was developed, and resistant varieties were developed^[11].

In 2005, the Basic Plan for Food, Agriculture and Rural Areas was revised, and in 2006, the new demand wheat and barley research project was conducted. Currently, a project (launched in 2010) is underway to develop technology for effective year-round use of agricultural land by maximizing the potential of rice fields. This project aims to improve the food self-sufficiency rate by effectively using rice fields in winter (and so using agricultural land all year around), and research and development has been conducted to improve the productivities of high-quality varieties that have been developed.

In addition, in March 2010, the Cabinet determined the second revision of the Basic Plan for Food, Agriculture and Rural Areas. Recognizing that the world’s supply and demand situation for cereals is expected to be tight in the medium and long terms, and the plan aims to improve the food self-sufficiency rate by 50% (on the calorie basis) in 2020. The plan lays out some issues to address regarding production including the following: cultivating varieties for bread and ramen noodles with good quality and good yield performance; promoting double cropping in rice fields by cultivating good-quality late-maturing wet rice varieties; and extending the use of domestically produced wheat currently used in udon noodles into bread and confectionery by, for example, establishing processing technology. The plan has set a quantitative target and aims to increase wheat production to 1.8 million tons, about double the current amount^[12].

4-2 Trends in Research on Genetic Characteristics of Wheat

When flour is kneaded with an adequate amount of water, gluten and gliadin (major components of protein contained in flour) mix to form viscoelastic gluten. This occurs because the water and the kneading action give rise to a large net-like polymer structure^[13] (Figure 7). The characteristics of bread and noodle dough depend on the quality and quantity of gluten, and appropriate types of flour must be used

Table 3 : Major Recent Agricultural Policies Concerning Domestically Produced Wheat in Japan

1998	The new wheat policy outline was published.
1999	The urgent development project concerning new wheat and barley varieties launched.
1999	The Food, Agriculture and Rural Areas Basic Act was enacted.
2000	The Basic Plan for Food, Agriculture and Rural Areas was created.
2003	The Integrated Research for Providing Fresh and Delicious “Brand Nippon” Agricultural Products launched.
2005	The Basic Plan for Food, Agriculture and Rural Areas was revised (1 st time).
2006	The new demand wheat and barley research project launched.
2010	The project to develop technology for effective year-round use of agricultural land by maximizing the potential of rice fields launched.
2010	The Basic Plan for Food, Agriculture and Rural Areas was revised (2 nd time).

for different processed foods. Gluten-rich elastic strong flour is used for bread and ramen noodles, while medium flour (with intermediate quality and quantity of gluten) is used for udon noodles.

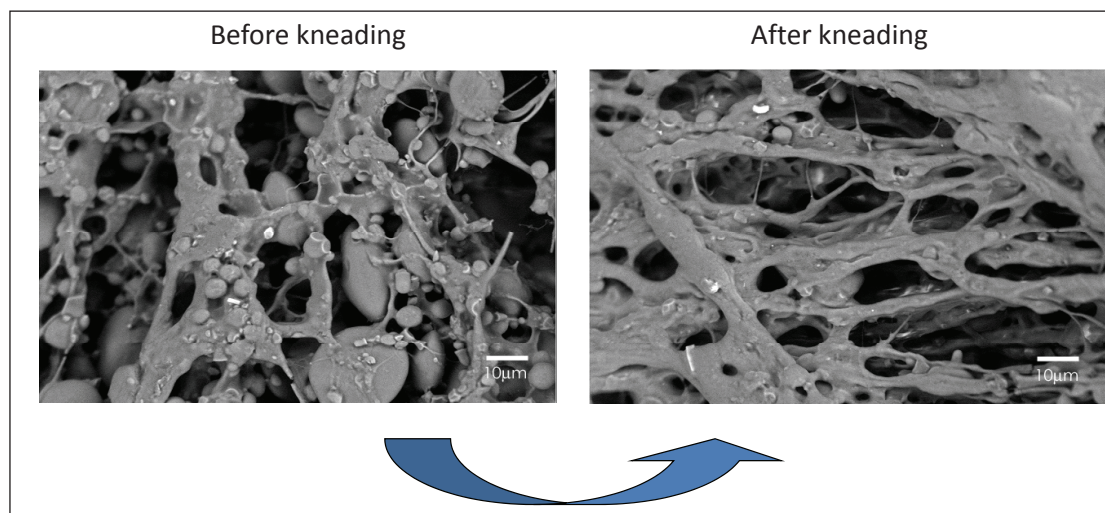
Cystines, a type of amino acid contained in glutenin, are bound together by a disulphide bond to form a large polymer structure with many intertwined molecules (Figure 8, left). Gliadins are present as monomers, loosely associated by hydrogen bonding, etc. (Figure 8, right). Due to these characteristics, glutenin expands and contracts like rubber, creating elasticity (strength), and gliadin is related to the viscosity of gluten^[14].

Glutenin can be categorized into high-molecular-weight subunits (molecular weight: 80,000–160,000) and low-molecular-weight subunits (molecular weight: 30,000–46,000). Even if overall protein content is kept the same, the viscosity and elasticity of gluten varies greatly depending on the glutenin subunit content ratio, composition, and degree of polymerization of each variety. There are four different types of gliadin: three types with molecular weights between 25,000 and 46,000 and one type

with a molecular weight between 46,000 and 70,000. Due to these factors, their processing suitability differs substantially.

Among various genotypes of high-molecular-weight glutenin subunits, it is becoming clear which subunits are more effective for making dough strong. More specifically, the shape of a polymer differs depending on the number of cystines, which bound together intermolecularly, and either low elastic straight-chain polymers or high elastic net-like polymers are formed. As to the effects of the genotypes of low-molecular-weight subunits on dough properties, the difference in the number of cystines does not matter, but the number and quantity of subunits and the difference in conformations affect dough properties^[14].

As such, extra strong dough can be made from wheat varieties that have a combination of high-molecular-weight and low-molecular-weight subunits such that the dough is strengthened. The dough is very elastic, and by mixing medium flour into this flour, one can create flour that is suitable for bread-making, etc., similar to strong flour. As such, extra strong flour is used for blending with other flours.

**Figure 7** : Scanning Electron Microscopic Image of Gluten^[15]

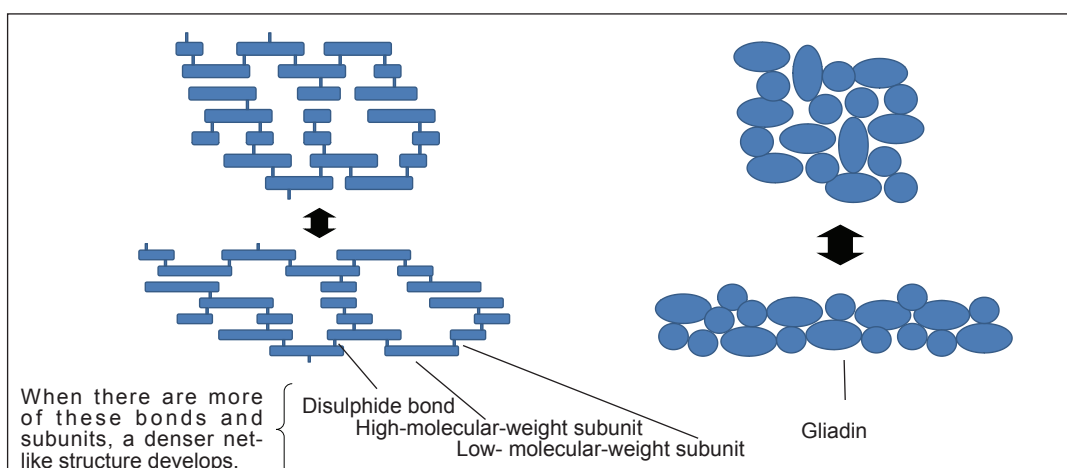


Figure 8 : Protein Characteristics for Visco-elasticity: Glutenin forms polymers through disulphide bonds and affects elasticity by expanding and contracting like rubber (left). Gliadin, aggregations of monomers loosely bound by hydrogen bonding, etc., affects viscosity (right)

Prepared by the STFC based on reference^[14]

Yumechikara, a new domestically grown wheat (which will be discussed in the next section)^[16], is known to have the same characteristics, and its dough properties are as strong as or even stronger than those of Dark Northern Spring wheat from the United States.

As discussed, it is possible to estimate dough properties to a certain extent from the combination of genotypes of glutenin subunits. It is also becoming possible to select high-quality wheat optimized for different processing purposes.

4-3 Trends in Cultivar Improvement and Action against Pre-harvest Sprouting and Wheat Diseases in Hokkaido

Hokkaido is the largest wheat producer in Japan, making up 60–70 % of the total wheat production in the country. Most wheat is vulnerable to high temperature and humidity, and its cultivation is suitable in regions where it is dry and cold during the harvesting season. Hokkaido does not have a rainy season and is suitable for growing wheat. In addition, large-scale farming is feasible in Hokkaido. For example, the Tokachi district's land area is larger than Tokyo, Chiba, and Kanagawa prefectures combined and has long developed large-scale farming. Its average cultivated acreage per farm is twenty-four times larger than the country's average. In addition, the Ishikari district has been emphasizing the cultivation of new strong wheat varieties with support from Ebetsu Flour Milling Co. Ltd. and other locally operating companies^[8].

Haruyutaka and Haruyokoi are representative

domestically produced wheat varieties used for bread and which are in demand. However, Hokushin, a medium flour, makes up about 90% of wheat production in Hokkaido, followed by Haruyokoi (~4%), Kitanokaori (~1.5%), and Haruyutaka (~0.6%), and so the production of bread-making wheat is still rare.

The National Agricultural Research Center for Hokkaido Region of the National Agriculture and Food Research Organization focuses on improving winter wheat rather than spring wheat in order to reduce wheat diseases through earlier harvesting. Yumechikara is one such new extra strong gluten wheat variety that shows excellent resistance to wheat yellow mosaic virus and Fusarium head blight^[16]. Since extra strong flour can be blended with Hokushin and other domestically produced medium flours to make the dough properties suitable for bread and ramen noodles, there is an expectation that the consumption of domestically produced wheat will increase.

Yumechikara was created in 1996 by crossing Satsukei 159/KS 831957 (F1) with Tsukikei 9509 (Kitanokaori). Satsukei 159 has excellent over-winter ability^[17]. KS 831957 (F1) (introduced from Kansas State University) has excellent bread-making quality and extra strong dough quality traits. Yumechikara was adopted as a good-quality variety in Hokkaido in 2008 for its excellent resistance to wheat yellow mosaic virus (which has been causing damage to the wheat growing regions in Hokkaido) and for its excellent processing properties when it is used in blends.

Processing adequacy evaluation is also conducted for blends with other wheat produced in Hokkaido^[16]. Bread-making properties were tested for blends of Yumechikara and Hokushin, Japan’s core variety, with different blend ratios. As the ratio of Yumechikara goes up, the elasticity and consistency improve, the volume increases, and puffier bread can be made. However, dough made from 100% Yumechikara is too strong and less workable, causing the bread to fail to rise and to thus become hard and distasteful. Testing has shown that a blend of Yumechikara with 25–50% Hokushin improves the workability of the dough, and the bread becomes puffy, increasing the overall evaluation score (Figure 9).

5 For the Future Development of Domestically Produced Wheat

5-1 Promoting the Research and Development of Wheat

As discussed earlier, the world’s wheat prices are rising and becoming unstable due to the concentrated wheat production regions, the increase

Table 4 : Wheat Varieties Produced in Hokkaido

	Variety	Use
Winter wheat	Hokushin	Japanese noodles
	Kitahonami	
	Horoshirikomugi	
	Kitamoe	
	Kitanokaori	Bread, ramen noodles
Yumechikara		
Spring wheat	Haruyutaka	Bread, ramen noodles
	Haruyokoi	
	Harukirari	

in the population of wealthy people in emerging countries, and global climate change. Expectations for domestically produced wheat are growing because of concerns over food security and the rise in the awareness of food safety among consumers.

However, as illustrated in Figure 6, the prices of domestically produced wheat are still much higher than imported wheat. As discussed in Section 1 of Chapter 4, since the late 1990s, the Ministry of Agriculture, Forestry and Fisheries and other organizations have been trying to improve technologies concerning high-yielding varieties and cultivation. However, the scale of such research and development is small and scattered, and human resources are scarce.

Milling companies, bread-making companies, noodle-making companies, and others strongly desire a stable supply of domestically produced wheat of consistent quality. High-quality, good varieties have been researched and developed, but production and quality still vary greatly depending on the year and location. For example, there are many orders for Haruyutaka, a domestically produced strong wheat introduced in Chapter 4, but production is not able to meet demand. As a result, sales had to be scaled back in 2009 and 2010.

As such, it is important to develop particularly stable quality wheat and improve yields. To this end, it is essential to substantially enhance research and development of domestically produced wheat at public research institutes and universities. In addition, it is hoped that related companies will improve milling, bread-making, noodle-making, and quality assessment technologies.

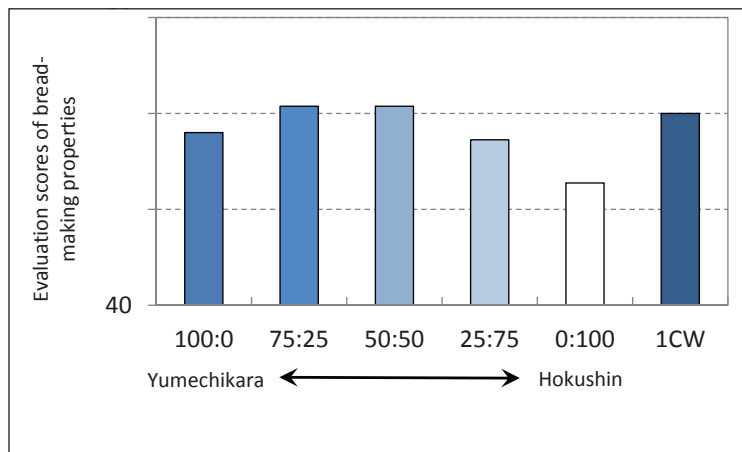


Figure 9 : Ratios between Yumechikara and Hokushin and Bread-making Properties (1CW: Western Red Spring from Canada)

Prepared by the STFC based on reference^[16]

To realize lower costs as well as consistent quality and stable supplies, the following two issues should be addressed through wheat-breeding research.

Firstly, diseases that occur right before harvesting during the hot and humid season (such as Fusarium head blight, wheat yellow mosaic virus, and pre-harvest sprouting) must be prevented. Rival wheat varieties from overseas do not need to have resistance to Fusarium head blight and pre-harvest sprouting, and so this is a unique problem for Japan to overcome since the country has a rainy season.

The DNA marker selection technique has been drawing attention as a way to accelerate research. Each wheat variety has slightly different DNA base sequences, and with these differences as markers, it is possible to indirectly select for good tastes and other useful qualities based on genetic differences. By doing this, one can substantially reduce the selection time compared to the conventional selection based on repeated crossings and screenings. For example, by combining the conventional selection technique and the DNA marker selection technique, one only needs to extract DNA from a leaf at the seedling stage in order to select useful qualities from different varieties, and it is possible to check multiple qualities in a short time without taking much time and effort for crossings and cultivation. As such, it is desirable to effectively use the DNA marker selection technique.

Secondly, improving wheat cultivation properties should be addressed in breeding research. Even if disease-resistant, high-quality varieties are developed, it is meaningless without a technique with which each farm can stably cultivate wheat. Some high-quality domestic wheat varieties have been developed, but a cultivation technique to secure a stable yield every year has not yet been established. This is because producers have slightly different ways of growing wheat, and so they cannot keep the qualities at the same level. As a result, the food-processing costs become high. It is essential to establish a stable and versatile cultivation technique and to create a system to provide accurate information and support to producers by, for example, educating on different types of additional fertilizers and when to use them to combat various diseases.

5-2 Establishing Wheat Brands and Further

The Strategies of Assuring Intellectual Property for the Ministry of Agriculture, Forestry and

Fisheries was formulated in March 2007, and intellectual property policy began to really take effect in agriculture, forestry, and fisheries¹⁸]. In these fields, there are various intellectual properties, including new crop varieties at production and processing stages (plant breeders' rights), technology development results (patents, utility models), gene patents, designs at the sales stage (design rights), naming (trademark rights), on-site technologies and know-how, and intangible information on local brands and food culture¹⁹]. The Strategies aim to comprehensively create, protect, use intellectual properties in agriculture, forestry, and fisheries to enhance competitiveness in agricultural, forestry, fishery, and food industries, and realize regional improvement²⁰]. In March 2010, to facilitate this trend, the New Strategies of Assuring Intellectual Property for the Ministry of Agriculture, Forestry and Fisheries were formulated²¹]. In particular, emphasis is placed on local brand strategies for survival of domestic producers, and through the strategies, unique local value is identified and then sold as valuable products. As such, it is essential to realize regional improvement and vitalize the food industry by improving the quality of domestically produced wheat and establishing brands.

Agricultural and marine products and food fit naturally into the concept of local brands²²]. When creating a brand, it is important to establish the inherent value of the product. In the case of wheat, the quality (taste, nutritional value, etc.) of the food processed from wheat must be high. However, local brands cannot be based on this alone. It is essential to have sales strategies to appropriately convey the food value and the connection to the region. As discussed earlier, cultivars, cultivation techniques, naming, etc. can be protected by intellectual property rights. To promote local brands, it is necessary to manage and use these intellectual properties in an integrated manner.

As an extension of local brand strategies, it is also essential to examine international strategies for domestically developed wheat. While Japan's food market is expected to shrink in the long term, the world's food market is projected to grow due to the increase in wealthy people in Asian countries and elsewhere, the globalization of Japanese food, etc. The production of conventional wheat varieties is concentrated in certain regions due to their strong

environmental affinities. As such, it is critical to, first, establish intellectual property rights for cultivars (that are resistant to a hot and humid climate) and cultivation techniques, and to take them overseas and cultivate them locally. Through this process, one should convey the appeal of Japanese food and improve the recognition for high-quality Japanese agricultural products. Farmers and the agricultural cooperative association are, of course, the center of these activities, but the National Agriculture and Food Research Organization, regional agricultural research centers, and regional independent administrative institutions have accumulated advanced knowledge concerning cultivar improvement, new cultivation techniques, gene technology, etc. In addition, the Japan External Trade Organization (JETRO) provides excellent know-how and support concerning business localization overseas. These individuals and organizations are expected to cooperate to produce and sell Japanese wheat overseas.

Acknowledgment

We would like to express our appreciation to Dr. Shunsuke Oda (National Institute of Crop Science, National Agriculture and Food Research Organization) for his valuable advice and to Dr. Tatsuya Ikeda (National Agricultural Research Center for Western Region, National Agriculture and Food Research Organization) for providing valuable resources. We would also like to thank Ms. Asuka Osawa (Annie and Keity) for providing samples and educating us on bread-making and to Mr. Yoshihiko Yamamoto (Ebetsu Flour Milling Co. Ltd.) for showing us the milling process.

References

- [1] Statistics Bureau of the Ministry of Internal Affairs and Communications, Family Income and Expenditure Survey (2011)
- [2] Ministry of Agriculture, Forestry and Fisheries, Circumstances surrounding wheat (2010)
- [3] Ministry of Agriculture, Forestry and Fisheries, Prospects on wheat supply and demand (2011)
- [4] Shunsuke Oda, Processing properties of new domestically cultivated varieties and future direction of breeding, the second gluten research group (2010)
- [5] U.S. Department of Agriculture, Grain: World Markets and Trade (2010)
- [6] U.S. Department of Agriculture, World Agricultural Production (2010)
- [7] Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries, Outlook of the world's food supply and demand in 2020—Estimate results based on the world food supply and demand model—(2011)
- [8] Etsuko Tsutsumi, Experimental study on the effect of regional improvement activities by collaboration between agriculture, commerce and industry, fiscal 2009 research article granted by the Hokkaido Development Association, pp.73–92 (2008)
- [9] Shunsuke Oda, Masumi Katsuta, Direction of research aimed to improve the food self-sufficiency by wheat

Glossary:

- Pre-harvest sprouting: Seeds sprout on spikes before harvesting. The phenomenon can happen to wheat, rice, corn, etc. due to rain and other climate conditions. It decreases yield and reduces quality. To address this problem, breeding has been conducted to select for early-maturity cultivars (that can be harvested before the rainy season) and cultivars that have genes with a strong latent tendency such that they do not easily sprout even upon absorbing water.
- Fusarium head blight: One of the most serious diseases for wheat and barley. When disease-causing fungi infect spikes, seeds may not become larger and entire wheat heads may wither.
- Wheat yellow mosaic virus: Symptoms appear as dashes and, later, yellowish-white streaks in young leaves. The virus lives in soil and is transmitted through soil by a soil-borne fungus. The virus can remain in soil for a long period of time. It is difficult to eliminate the virus and the transmitting fungi from the soil.
- Post harvest chemicals: Pesticides, fungicides, etc. used on agricultural produces after harvesting. In Japan, the use of post harvest chemicals after harvesting is banned. However, such chemicals are sometimes used on products when they are transported from the United States and elsewhere.
- Disulfide bond: A disulfide bond is a covalent bond with a bridged structure and is formed from the oxidation of SH groups (two cysteine residues). The overall structure is R-S-S-R.

- and barley production, Research Journal of Food and Agriculture, Vol.33, No.11, pp.5–8 (2010)
- [10] Ministry of Agriculture, Forestry and Fisheries, New wheat policy outline (1998)
- [11] Agriculture, Forestry and Fisheries Research Council, Integrated Research for Providing Fresh and Delicious “Brand Nippon” Agricultural Products (2007)
- [12] Ministry of Agriculture, Forestry and Fisheries, Basic Plan for Food, Agriculture and Rural Areas (2010)
- [13] Tadashi Tabiki, Breeding of extra strong wheat "Yumechikara," Research Journal of Food and Agriculture, Vol.33, No.11, pp.15-19 (2010)
- [14] Tatsuya Ikeda, Relationships between processing properties of flour and gluten protein composition and high-quality cultivar development, Research Journal of Food and Agriculture, Vol.33, No.11, pp.9–14 (2010)
- [15] Tatsuya Ikeda, Gene cluster that determines gluten quality and bread-making, the second gluten research group (2010)
- [16] National Agricultural Research Center for Hokkaido Region, National Agriculture and Food Research Organization, Extra strong winter wheat “Yumechikara” for Hokkaido (2010)
- [17] National Agricultural Research Center for Hokkaido Region, National Agriculture and Food Research Organization, Cultivation of new cultivar “Yumechikara” (2010)
- [18] Research group on intellectual property in agriculture, forestry, and fisheries, Easy-to-understand intellectual property rights in agriculture, forestry, and fisheries, Gyosei (2008)
- [19] Masatoshi Ichimura, Development of intellectual property strategies in agriculture, forestry, and fisheries and regional agricultural improvement, Regional policy research (Regional policy society, Takasaki City University of Economics), Vol.13, No.1, pp.39–49 (2010)
- [20] Strategies of Assuring Intellectual Property, Ministry of Agriculture, Forestry and Fisheries (2007)
- [21] New Strategies of Assuring Intellectual Property, Ministry of Agriculture, Forestry and Fisheries (2010)
- [22] Ministry of Agriculture, Forestry and Fisheries, Promoting the establishment of regional brands for agricultural and marine products and food, 2009

Profile



Daisuke KANAMA

Affiliated Fellow, STFC

Associate Professor, Business Administration and Information Science, Hokkaido Information University

<http://www.do-johodai.ac.jp/>

Dr. Kanama has a PhD in engineering. He specializes in industry-academia cooperation and intellectual property, science and technology foresight, and research trends in nanotechnology. He has been analyzing industry-academia activities and engaging in technology foresight projects and is interested in medium and long-term relationships between technological trends and economic society.



Yoshihiko SUMI

Affiliated Fellow, STFC

Special Appointed Professor, Front Office for Human Resource Education and Development, Hokkaido University

<http://www.synfoster.hokudai.ac.jp/hop-station/>

Dr. Sumi is interested in creating innovations using biotechnology. He also considers it important to change education systems so that PhD graduates can play important roles not only in academia but also in the industry. While aiming to transform society, he continues to like playing analog records.

(Original Japanese version: published in July, August 2011)