

Unit 1-2: The evolution of agricultural production technology in Japan

## **Chapter 1 Introduction**

Agriculture, Forestry and Fisheries research plays an important role by providing strong support for the development of policies related to technologies in those industries. In carrying out research, policy-needs must therefore be ascertained precisely, and the research must be conducted effectively and in close collaboration with the administrative bureau. In order for people in agriculture, forestry and fisheries to effectively utilize the benefits of research into technologies that are related to their industries, it is important that the research be carried out in close collaboration with operations that can disseminate information and act as a bridge to the people in those industries.

## **Chapter 2 Development of Rice Cultivation in Japan**

Japan is located on the far east end of the Asian Monsoon zone, where the warm climate and heavy rainfall make it an extremely suitable place for growing plants. On the other hand, the Japanese landscape is very mountainous, with many slopes, and consists of alluvial plains situated among large river basins (compared to large rivers that run through major continents, the distance of rivers to the sea is shorter, and the river flow is faster). Due to these kinds of conditions, there is particular emphasis on rice cultivation in Japan, which has high productivity and can be carried out stably. Rice paddies that were initially developed along the alluvial plains eventually expanded widely to intermediate and mountainous areas, together with the development of flood control and irrigation facilities, and plains everywhere became filled with rice paddies.

Agricultural production in Japan was developed with a focus on wet-rice cultivation. Agricultural conditions in Japan are outlined below, with a focus on the background of the development of technology for wet-rice cultivation.

### **2.1 The Evolution of Wet-Rice Cultivation**

It has been estimated that the wet-rice crop yield in the 1880s was approximately 4.5 million tons. In the latter half of the 1960s, however, the crop yield was 14.2 tons, more than 3 times the amount in the 1880s. The area under wet-rice cultivation in 1888 was a little more than 2.64 million hectares, but after a continuous increase caused by responding to expansions in market demand, together with rapid modernization, the area under cultivation reached approximately 3.10 million hectares in 1932. This increase was revitalized after World War II, as a result of political measures to increase food production, and in 1962, the area of land under wet-rice cultivation exceeded 3.16 million hectares. Since then, the total

area under cultivation has been declining, due to a period of adjustments in production.

Although the yield per 10 acres of land used to be at a level of less than 200 kg, in 1915, after various technologies brought about the modernization of farming methods, the yield rose by 46%, to 280 kg per 10 acres of land. The increase in crop yield after 1955 was remarkable, increasing from a level of 330 kg to 500 kg in 1978, representing an increase of over 50% during a time span of 23 years.

[Adjustments in the Production of Rice]

Adjustments in the production of rice began in 1969, caused by a surplus production of rice. Initially, adjustments mainly consisted of halting rice cultivation, but afterwards changed and came to consist of measures emphasizing crop rotation and land diversion from rice to other crops.

Fig. 2.1 Shifts in the Rice-Field Average and Unit Crop (1885-1985)

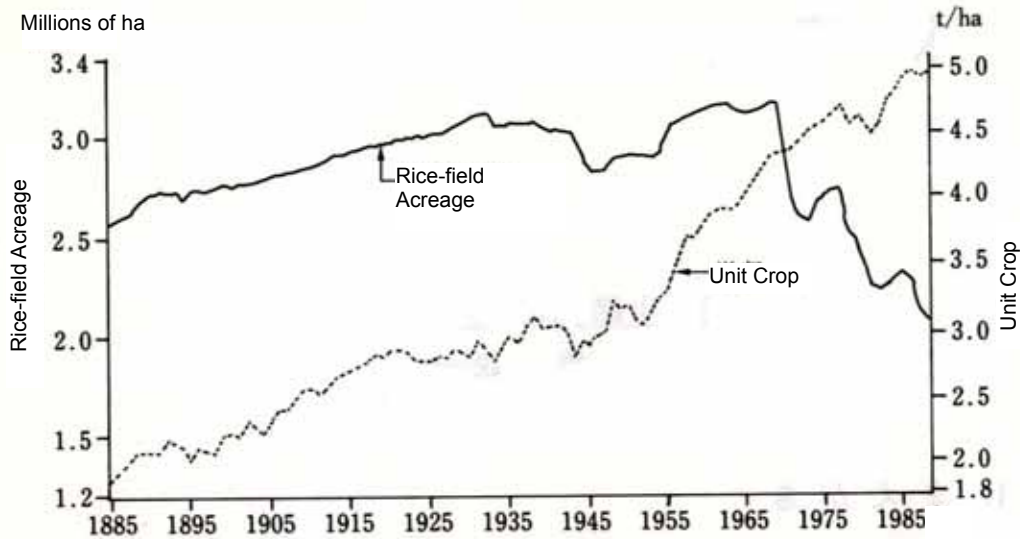
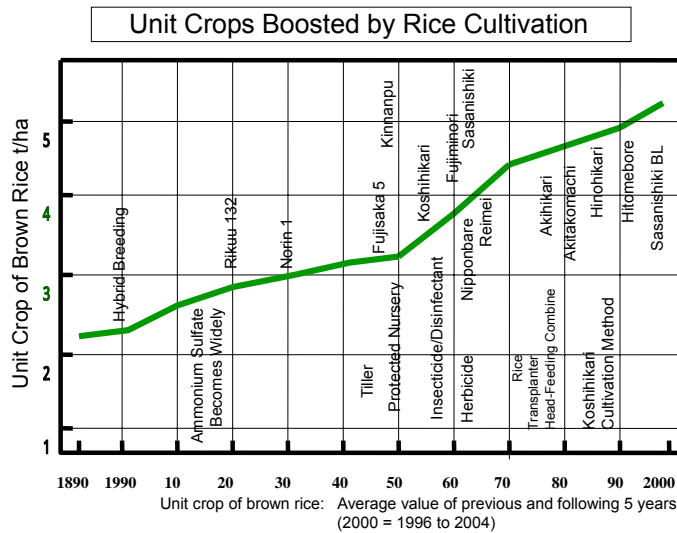


Fig. 2.2 Rice Cultivation and Shifts in Unit Crop of Brown Rice



## 2.2 Development of Technology for Wet-Rice Cultivation

### 2.2.1 Development of New Varieties

#### (1) Specified Exam Operations

Since its establishment in 1926, Specified Exam Operations has been taking approaches towards development of soil management technology and technology for

agricultural pest control and developing breed varieties. Currently, Specified Exam Operations is involved in two large challenges: a breed improvement exam and an exam for responding to key problems. Based on long-term and national perspectives, from among the exam research that should be conducted by the government, Specified Exam Operations implements those that are difficult to be carried out by independent administrative organizations due to location requirements, by commissioning specified prefectural exam research institutes (“public institutions”) located in suitable areas to conduct research. Up until now, Specified Exam Operations has cultivated prominent varieties such as “Koshihikari” and “Hitomebore” for paddy rice, “Hokushin” for wheat, and “Enrei” for soybeans.

There have been significant results for the breed improvement exam, with 52% of the breeds developed by the government (1,718 breeds in all as of 2004) being developed at specified exam locations. In addition, 70% of the national rice-field acreage and 79% of the national wheat-field acreage are being used to cultivate breeds developed by specific exams.

## (2) Germ Plasm Acquisition and Preservation

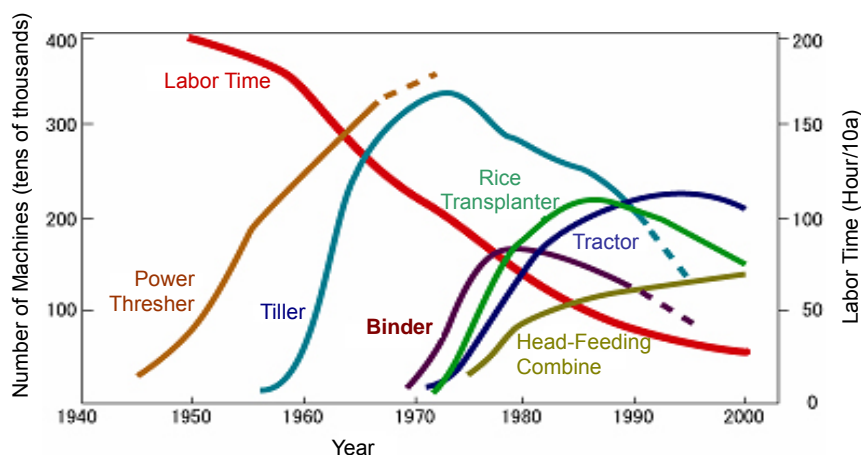
Compared with the abundance of genetic mutations for rice throughout the world, the mutations of the breeds of rice cultivated in Japan are extremely small. To significantly improve Japanese rice, it has become necessary to gather different breeds of rice from foreign countries around the world, and to use these as germ plasms. There have been attempts to introduce unusual types of rice from foreign countries into Japan since the prewar period, but research on importing foreign breeds and preserving and using them as genetic resources came to be conducted in earnest only after the war. Before long, the importance of genetic resources came to be acknowledged, and is passed on now in the form of large-scale gene banks.

### 2.2.2 Mechanization of Wet-Rice Cultivation

The mechanization of agriculture in Japan, which used to depend on human power and animal power, began when irrigation pumps came to be produced domestically in the latter half of the 1920s. The mechanization of rice cultivation was first represented by the power thresher, and progressed with the popularization of the cultivator, rice transplanter, tractor, and head-feeding combine, enabling for substantial laborsaving and freeing farmers from hard labor. Afterwards, general-purpose combines that make harvesting of oats and soybeans possible, and high-speed rice planters that improve work efficiency by 1.3 times by using a method of rotary sowing were developed. Recently, there has been development and popularization of radio-controlled helicopters that are capable of spraying pesticides,

and nowadays, there is progress on the development of robots for agricultural use, such as self-running tractors.

Fig. 2.3 Changes in the Popularization of Agricultural Machines and Labor



Self-running rice transplanter using GPS

### 2.2.3 Consolidation of Agricultural Fields as Rice Paddies

To deal with food shortages after the war, land reclamation operations were implemented starting in 1947, with a goal to cultivate 1.55 million hectares of land in 5 years. Readjustment of arable land was also to be carried out for rice paddies as well. As research and development during these 5 years, progress was made on research related to water-saving irrigation, securing water for irrigation, and soil preparation/subsoil compaction/admixture of soil/uprooting, all of which was based on fundamental research on soil and water, such as the physical properties of soil and permeability of water. There was also a transition from cattle tilling to power tillers, and the plot dimensions for rice paddies became composed of mostly 10-are plots.

After 1955, the food situation was gradually alleviated due to various efforts to increase production, starting with rice, and resulted in a turnover from focusing mainly on increasing food production to expanding the scale of management and improving labor productivity. In terms of research and development, there was also research on power-saving technology for stable and high yields in wet-rice cultivation. More specifically, progress was made on the development of preparatory tillage, rice planting, fertilizing, and harvesting techniques based on large machinery, and, in response to this development, research on dimensions for rice paddy plots and the necessary soil bearing capacity was also conducted. The consumption mechanism for irrigation water and water movement, such as permeation, in rice paddies, was also clarified, and there has been research related to irrigation canals,

drainage canals, and underdrainage that are necessary for expansion of plots and well-drained paddy fields.

### 2.3 Changes in the Demand for Rice and Evaluation of Paddy Fields

In the postwar period after 1945, rice production was unable to catch up to the market demand, and large amounts of oats and rice were imported. To aim for increased production of rice, the government proposed developing new breeds of rice, developing infrastructure for drainage, conducting large-scale land improvements, increasing production of chemical fertilizers, and developing new fields. As a result of these kinds of approaches, there was a definite increase in the amount of rice produced after 1955, and around 1965, self-sufficiency in rice was completely achieved.

After this period, improvements in the daily lives of people were accompanied by a diversification in dietary lifestyles, and due to an increase in the consumption of meats and fatty foods as substitutes for rice, the demand for rice started to decline, after reaching a peak in 1967 when the annual production was 13.41 million tons. In relation to this demand, there was a continuous level of large production amounts starting in 1967, when the production amount exceeded 14 million tons, resulting in substantial production surpluses.

Consumption of rice is on the decline even today, and in 2004, the consumption amount per person was 61.5 kg, which is only half of the amount consumed in 1962 (118 kg per person) when consumption was the highest. Recently, the scale of production adjustments has been expanding consistently. In 2003, there were efforts throughout Japan towards production adjustments for 39% of the rice-field acreage, equivalent to 1.06 million hectares of land, but regardless of widespread production adjustments, the current situation is one where the price of rice is declining.

The rice paddies that continue to expand throughout Japan have a wide variety of functions even in society today. In a report entitled "Evaluating The Multi-functions of Agriculture and Forests Related to The Global Environment and Human Beings," the water control function, in which the rice paddies that are expanding towards all regions of the sloping Japanese terrain play a role in, are highly evaluated, with budgets of 3.5 trillion yen annually as a flood protection function, and 1.5 trillion yen as a function for stabilizing river discharge duration. It has become necessary to maintain these kinds of multifaceted functions in the future by making effective use of rice paddies.

### 2.4 Changes in Research Goals Related to Wet-Rice Cultivation

From the period during which increases in food production took place to a period when production adjustments for rice were carried out, the development of different breeds of rice

has changed, based on trends in market demands towards more tasteful rice and using rice for other purposes.

The goals for research and development of rice during the postwar period were stable, high yields and changes towards light labor. The cultivation of breeds with lodging resistance traits and low plant height, and the cultivation of heavy manuring contributed to an increase in yield, and the development/popularization of pesticides and agricultural machinery dramatically increased the productivity of labor. The average yield of rice per 10 ares of land in 1954 was 338 kg, and the labor time was 190 hours, but in 2004, the average yield per 10 ares was 530 kg, and the labor time was 30 hours, indicating that during a span of 50 years, unit crop increased by over 50%, and labor time was reduced to 1/6 the original amount. When the production amount of rice came to exceed the market demand, the disparity of prices between different brands became large, and it is for this reason that "Koshihikari," which has a high demand for having good eating qualities, became widely cultivated, making up 38% of the current rice-field acreage. Even for breed improvement, enhancing eating quality is the top goal, and there are numerous breeds with good eating qualities that are being developed.

The importance of research and development of rice for the purpose of stable, high yields and good eating qualities remains the same even today, but on the other hand, there has been progress on research and development for new purposes, to respond to the diversification of consumers' needs. Starting in 1989, in a research project entitled "Development of Lowland Crops with New Traits for Expanding Demand," the characteristics of proteins and starches in rice were clarified, and the cultivation of breeds for new purposes and development of processing/usage techniques were initiated. Afterwards, this project continued research on high-quality/highly functional rice to be made into brands, as well as research on low-cost/power-saving rice cultivation and rice for usage as animal feed. Based on the results from such research, a second research project was initiated in 2006 to respond to social needs. As for the provision of agricultural products for processing/commercial use that are adapted to changes in dietary lifestyles, improvements in the quality and productivity of Japanese agricultural products have been sought after, due in part to the superiority of imported agricultural goods. Consequently, there has been progress on research related low-cost rice for commercial processing in a research project entitled "Development of Technology for Stable Provision of Low-Cost and Good-Quality Agricultural Products for Processing/Commercial Use."

In the "Basic Plan on Food, Agriculture and Rural Areas" that was newly approved by the cabinet in March 2005, the goal is to increase the self-sufficiency ratio to 45% (currently 40%) on a calorie base. To achieve this goal, it is important to widely increase the

self-sufficiency ratio of forage, which is currently remaining at 24%. As a result, in a research project entitled “Development of Technology for Japanese Animal Feeding through Large Supplies of Coarse Feed,” research on the production of high-quality forage rice is being conducted.

## 2.5 Developing New Rice Varieties

### 2.5.1 Fostering good eating quality

For general consumption, cultivation of edible varieties is concentrated on brand varieties like the popular *Koshihikari* and a large number of varieties just below *Koshihikari* in quality. These varieties are all derived from *Koshihikari* parents. Consequently, they have the same weaknesses such as including low resistance to diseases and the tendency to collapse. It is under these circumstances that efforts have been made to develop rice varieties that possess various resistance properties while maintaining their good eating quality. Recently developed varieties include those resistant to rice blast, leaf stripe, and are short-culmed.

### 2.5.2 Fostering good eating quality varieties adapted to direct seeding

Given the importance of expanding the scale of rice cultivation and lowering production cost, direct seeding cultivation is a pivotal goal of technology development. Direct seeding of irrigated rice peaked at 55,000ha in 1974 and decreased to 7,184ha in 1993. However, as of 2005, it recovered to 15,752ha. Particularly, direct seeding flood cultivation increased in the Hokuriku and Tohoku Districts. One reason direct seeding cultivation stagnated from 1974 to 1993 is that budding and the first transplanting of rice seedlings are unstable. Another reason is that transplant culturing is relatively susceptible to falling, resulting in low yields. For these reasons, to promote the spread of direct seeding cultivation, it is important that rice varieties be developed that can resolve these issues. Up to now, many varieties have been bred. And today, high-yielding, strains of rice with good eating quality have been developed. The frontal push down resistance (the fall resistance index in case of direct seeding cultivation) of these strains is more than double that of the indicator variety. In addition, an intermediate matrix into which soil budding is introduced has been developed, and the prospect for practical application is good. Moreover, in cold regions, efforts are being made to breed varieties that bud at low temperatures.

### 2.5.3 Rice as feed

Interest in so-called “feed rice” (rice used as rich feed for beef cattle and other livestock) began to increase around 1975, occasioning the development of extremely high-yielding rice varieties. At the same time, researches on ways to cultivate high-yielding varieties were conducted, resulting in the discovery of the importance of applying different fertilizers at different stages of growth. The use of this cultivation method resulted in yields of 800-900 kg in years of favorable climate conditions, and in the best year, an extremely high yield of 990 was achieved. But the use of the new varieties as feed for growing cattle did not spread, the reason being that in those days the cost of growing and marketing the new varieties exceeded the returns from their sale.



Rice variety as feed for feeding livestock (right)

Since then, interest has shifted to the use of whole crop silage (WCS) rice as a high quality cattle feed. WCS is prepared by harvesting the stem and ears together during the yellow ripe stage, that is, just before the rice is fully ripe, and allowed to ferment by the action of the lactic acid contained in the rice. WCS feed is nutritional, tasty and easy to store, and because every part of the rice plant is used, it is more cost effective than “rice feed, “which uses only the grain.

Evaluation of WCS as feed and research on a machine operating system had been conducted before 1991, but when a harvesting machine solely for harvesting rice as feed was developed in that year interest in rice as feed intensified. (The said harvesting machine was developed by joining the reaping part of a combine with the part for framing a roll baler.) Since then the machine, together with a self-propelled bale wrapper, has continued to be available to the general public.



Multipurpose harvester

The use of WCS as rotation crop for adjusting production has also been actively promoted. As a result, the area used to cultivate WSC has expanded. By 2005, it reached 4,600ha nationwide. Since 1999, the combined harvesting of stems, leaves and ears has resulted in high yields, and around that time, research was launched to develop varieties with high nutrient content for use as fodder. Today, varieties developed in that research are being cultivated in various regions across Japan.

New research developments in breeding — New research in rice breeding based on the results of rice genome research —

The rice genome information is essential to developing epoch-making rice varieties. An international rice genome-sequencing consortium with the initiative of Japan has now known the full genome sequence of a rice variety called “Nihonbare” in December 2004. These basic research results are used to isolate genes that are related to the yield, plant type, ear-forming time, etc., and for crossbreeding or gene recombination technology using genome information.

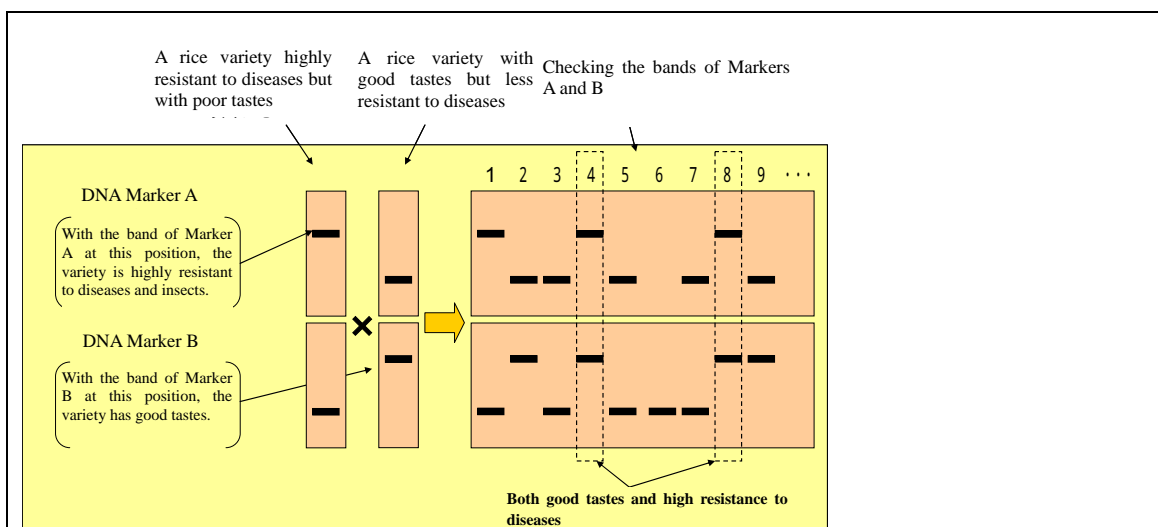
(1) Breeding with DNA markers

In the conventional breeding process, it is necessary to actually cultivate plants, and observe the yields, and the occurrence of diseases under conditions where such plants are more susceptible to diseases in order to select plant lines with preferable properties such as high yields and high resistance to diseases from among a range of varieties expanded, e.g., by crossbreeding. Such process, however, does not necessarily produce stable results, because of soil conditions and slight differences in weather conditions, so it is necessary to increase the number of test lots and crop years to accumulate data so that the properties of plant lines can be well studied.

As a result of developments in the genome study, however, DNA markers can be used for breeding to make it more effective. DNA marker breeding is a technological process where markers at the molecular levels that are involved in genes to produce high yields and high persistence to diseases are found to select plant lines with such properties. Lengths of DNA fragments obtained by means of enzymes to recognize and carve specific base sequences in DNA are used as markers. Selection of plant lines by such markers makes it possible to know their properties at the molecular level, so it is expected that the areas of test cultivation lots required to determine the plant properties can be reduced and the years required for breeding can be decreased (e.g., 15 years to three years), and thus the efficiency of breeding can be largely improved.

Nowadays markers to indicate the resistance to insects, good tastes, the resistance to cold climate, and so on, are explored for.

DNA marker breeding is different from the gene recombination technology.



## (2) Gene recombination technology

Recently, the gene recombination technology where genes are directly engineered has been rapidly developing. This technology takes out specific useful genes from a living organism and puts in another living form as a target to give new traits. A feature of this technology is that it can introduce genes from a different species or genetically modified genes, both which cannot be introduced by crossbreeding. There are no rice varieties created by means of gene recombination that have so far been put into practical use in Japan; however, there are increasing areas of cultivation of genetically modified crops such as soybean and corn in the world. This technology is expected to make great contributions to solving food problems on a global scale, developing sustainable agriculture by reducing agricultural chemicals, fertilizers, etc., and creating new industries in the future.

It is, however, very important to ensure the safety of the gene recombination technology. In September 2003, Cartagena Protocol on Biosafety to the Convention on Biological Diversity with the objective to ensure that measures in the field of the safe transfer, handling and use of living modified organisms are taken became effective internationally. Japan enacted and promulgated the Act to Ensure Biological Diversity by Restricting the Use of Genetically Modified Organisms in June 2003 to prepare itself for that Protocol for entering into it as early as possible, and actually joined it in November that year. Under that Act, researches and developments in the field of this technology are conducted with thorough public disclosure of information to fully ensure the safety and an understanding of the public.

With regard to rice, there are now researches in progress for varieties highly resistant to herbicides, diseases and insects, those abundant in tryptophan, which is an essential amino acid, and thus valuable as a feed, those without rice allergens, those capable of alleviating allergic symptoms to cedar pollens, etc., those capable of reducing neutral fats, and so on.

## Chapter 3 Technology Development System and Basic Research Plan

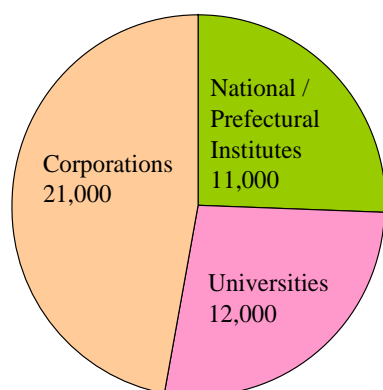
### 3.1 Influence of Agriculture, Forestry and Fisheries-related Research

In Japan research related to agriculture, forestry and fisheries is conducted in a systematic and planned manner through cooperation and role sharing among public research institutes, universities and the private sector, with the lead role usually played by independent administrative organizations.

Along with the 2001 reorganization of the central government, research organizations previously recognized as government institutes under the control of Japan's Ministry of Agriculture, Forestry and Fisheries were separated from the government and allowed to operate as independent administrative organizations. Currently six such independent administrative organizations (with total of 14 research institutes) are conducting research related to agriculture, forestry and fisheries. The number of researchers belonging to these research organizations is as shown in Figure 3.1. The relevant agriculture-related research institutes, both national and independent administrative organizations, are as shown in Figure 3.2.

Figure 3.1 Influence of Agriculture, Forestry and Fisheries-related Research

(1) Number of Researchers in Japan Involved in Agriculture, Forestry and Fisheries-related Research (including food industry)



(2) Breakdown of Researchers Involved in Research Related to Agriculture, Forestry and Fisheries by National / Prefectural Institutes

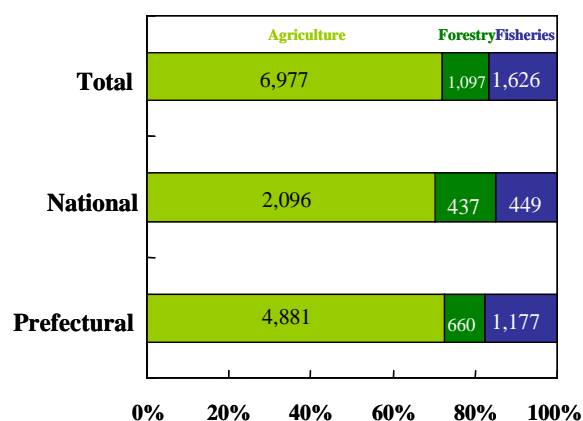
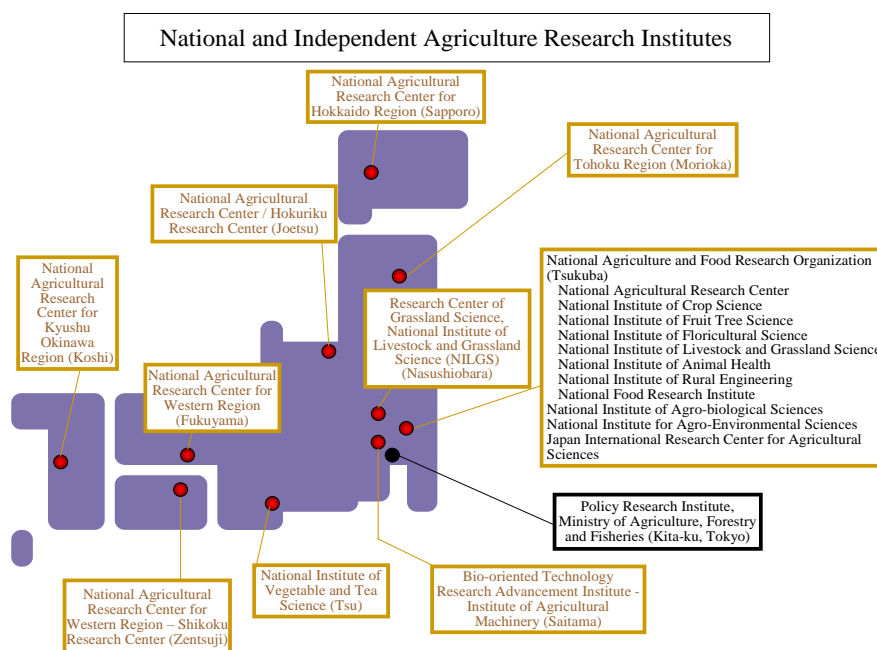


Figure 3.2 National and Independent Agriculture Research Institutes



### 3.2 Basic Plan for Agriculture, Forestry and Fisheries Research

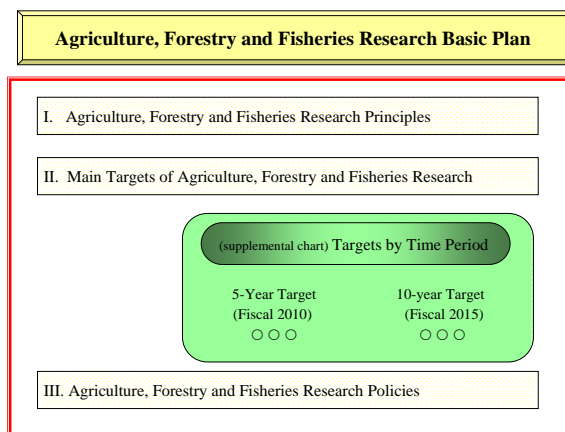
Japan established the “Main Research Goals for Agriculture, Forestry and Fisheries” in 1961 to set the basic direction for research in these areas. These goals have since been revised in line with changes in agriculture, forestry and fisheries policy. Then in March of 2005 the Agriculture, Forestry and Fisheries Research Basic Plan (hereinafter referred to as the “Research Basic Plan”) was established to clarify the social contributions that should be the aim of agriculture, forestry and fisheries research, taking into consideration Japan’s economic society, as well as global issues such as food supply and protecting the environment. The Research Basic Plan was also put in place to establish the main goals for research and development over the next 10 year, as well as specific policies for achieving these goals, and to convey these points to a wide range of people involved in research and the average citizens.

The following are the four main considerations for the Research Basic Plan

- (1) Use the major research institutes belonging to the national government and independent administrative organizations to place greater importance on the research being conducted by public research institutes, universities and the private sector and clarify the connections and role sharing among the government, industry and academia in conducting research for the nation in the fields of agriculture, forestry and fisheries.

- (2) Establish targets to be reached for specific periods, including numeric targets in the Research Basic Plan, and then use these targets for the systematic progress management of research and development activities.
- (3) Emphasize concrete approaches for policies that can start the reforms of the research and development system needed to generate exceptional results that will have practical and industrial applications.
- (4) Present in an easy-to-understand manner the social contributions made by agriculture, forestry and fisheries-related research, such as in the area of maintaining food safety and reliability, so that average citizens can fully appreciate the important roles fulfilled by this research.

Figure 3.3 Configuration of Research Basic Plan



### 3.2.1 Agriculture, Forestry and Fisheries Research Principles

Agriculture, forestry and fisheries research serves the two important roles of (1) providing research support for the development of agriculture, forestry and fisheries policy and (2) developing new technologies that will help to carve out a future for those industries related to agriculture, forestry and fisheries. This includes the big expectations held for research and development in the “Basic Plan for Food , Agriculture and Rural Areas”.

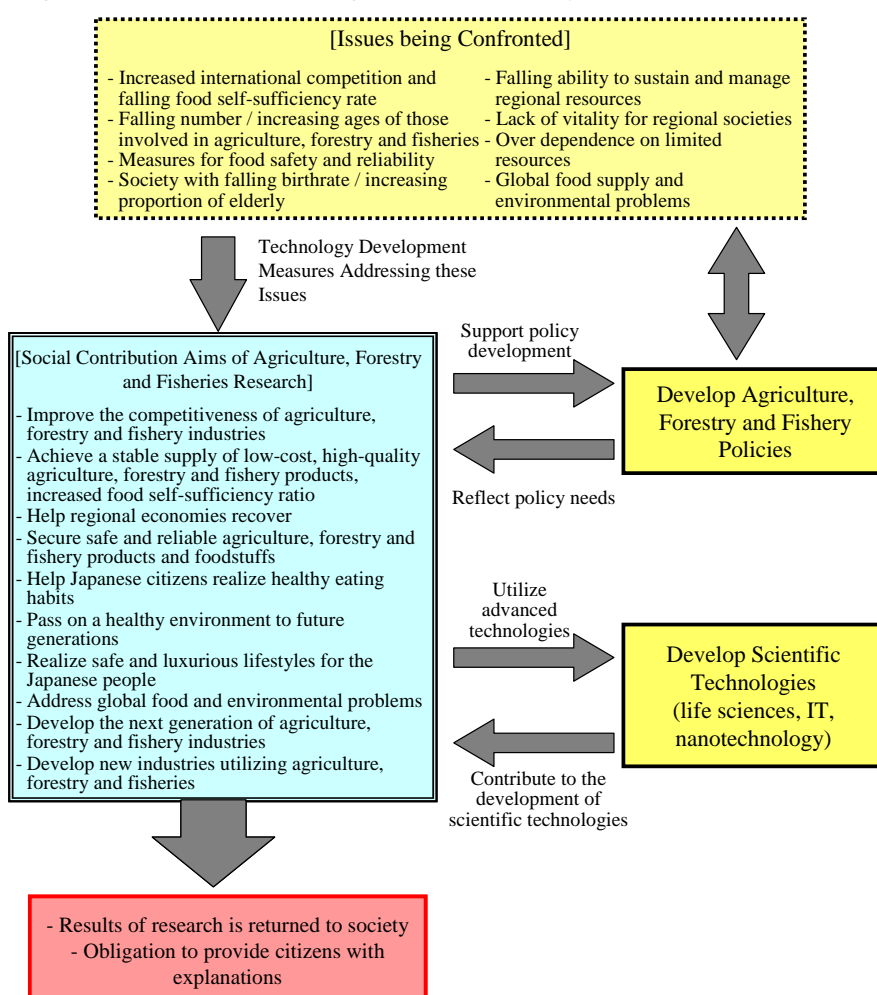
Furthermore, the issues being addressed by agriculture, forestry and fisheries research include many issues that are extremely important to average citizens such as Japan’s falling food self-sufficiency ratio, falling number of people willing to work in agriculture, forestry and fisheries, falling birthrate / increasing proportion of elderly people, and global food supply and environmental problems. Taking these points into consideration, agriculture, forestry and fisheries research is being aggressively promoted as shown in Figure 3.4 below.

Table 3.1 Main Food Supply, Agriculture and Rural Area Indicators from 1960 to 2000

	1960	1970	1980	1990	2000
Food Self-Sufficiency Rate (%)*	79	60	53	48	40
No. of Farm Houses (thousand houses)	6,057	5,342	4,661	3,835	3,120
Agricultural Workforce (10,000 people)	1,457	1,035	697	565	389
Arable Land Area (thousand ha)	6,071	5,796	5,796	5,243	4,830

\*Based on calorie supply

Figure 2.4 Principles of Agriculture, Forestry and Fisheries Research



### 3.2.2 Main Targets

Taking into account the social contributions that must be made by agriculture, forestry and fisheries-related research, the important research and development issues that will

need to be addressed over the next 10 years have been expressed as “main targets”.

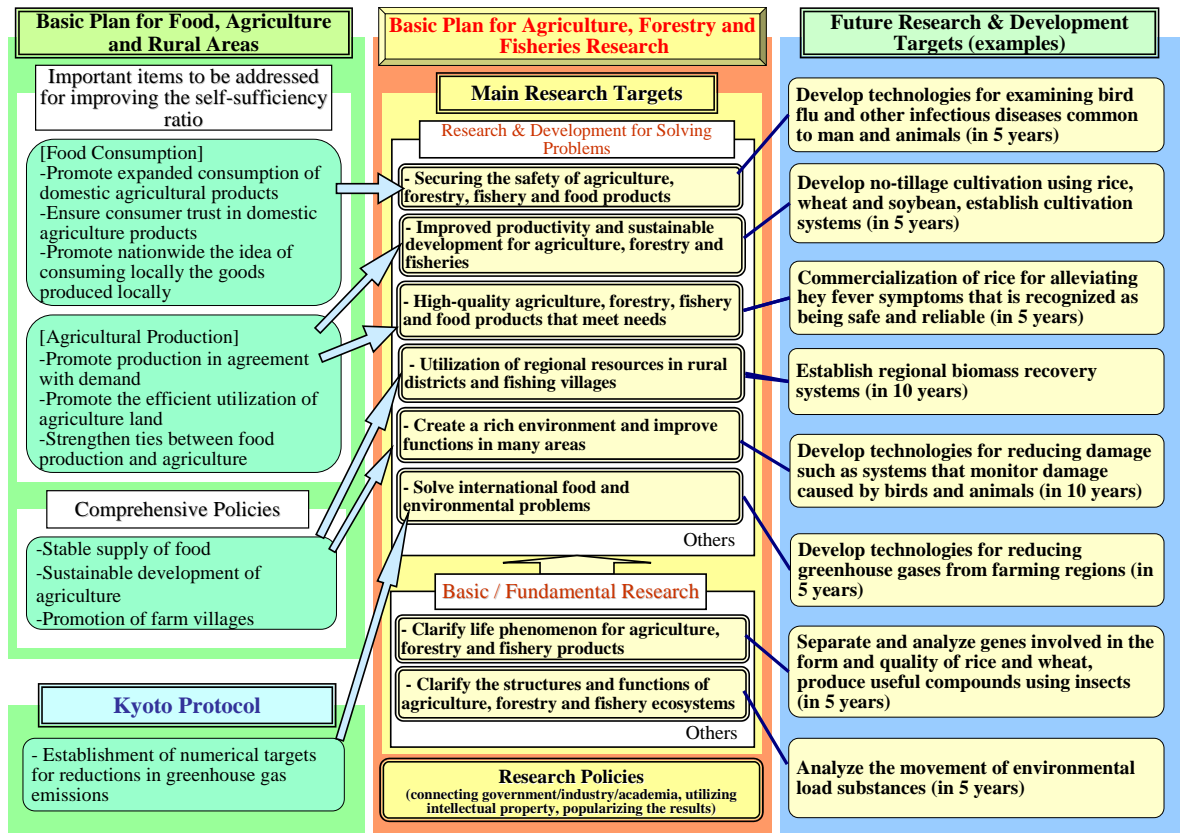
The main targets were set by taking into consideration the prevailing trends for research and development in agriculture, forestry and fisheries and related fields, as well as the policy requests for technical development and the setting of the basic direction for policy in terms of healthy and stable development for the agriculture, forestry, fisheries and food industries, maintaining food safety and reliability, promoting rural agricultural and fishing villages and other aims stipulated in the “Basic Plan for Food, Agriculture and Rural Areas”, “Basic Plan for Forests and Forestry” and “Fisheries Basic Plan”.

The first step was to establish seven research fields to be emphasized over the next ten years in light of the social contributions that must be the aim of agriculture, forestry and fisher research.

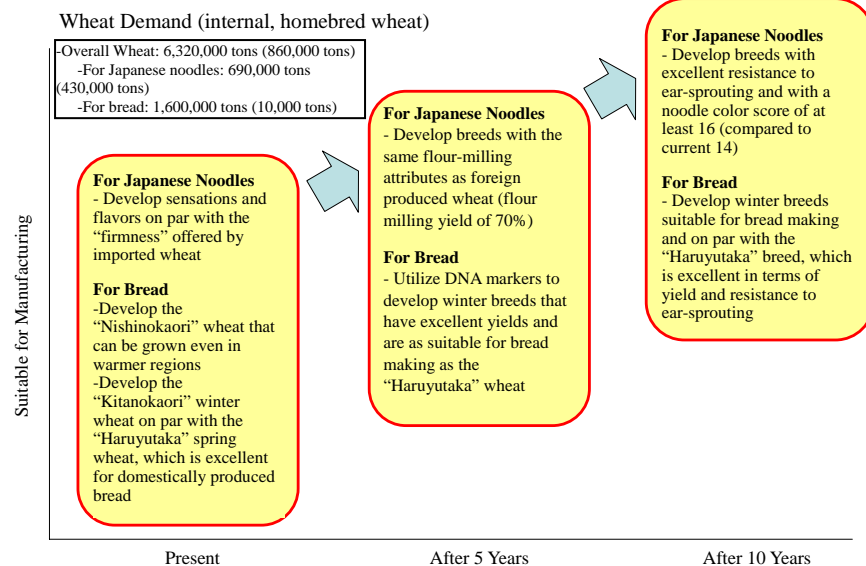
Then four research fields for the fundamental / basic research in the life sciences and environmental sciences supporting the above-mentioned seven fields were established, also to be emphasized over the next ten years.

Targets for research and development involving the main targets have been set for specific periods to clarify the exact levels that need to be reached over the next five years (fiscal 2010) and the next 10 years (2015). Efforts are being made to effectively combine various research policies in order to achieve these targets. Progress management is also being carried out through annual inspections and verifications of the research and development implementation and progress conditions. At the same time comprehensive assessments that are both objective and strict are carried out and the results of these assessments are reflected in the proper allotment of research resources.

Figure 3.5 Promotion of Research & Development based on Basic Plan for Agriculture, Forestry and Fisheries Research



## - Breed Development (wheat)



- Until now the domestically produced wheat used in bread has been limited to those breeds grown on the northern island of Hokkaido. However, winter breeds suitable for bread making that can be grown in various regions are being developed.

### <Social Contribution>

- Production of brands using domestically grown wheat can help stimulate regional economies.

The food self-sufficiency rate can be increased by reducing the amount of wheat imported for use in bread.

## Chapter 4 Direction of the Research for the Future Agriculture, Forestry and Fisheries

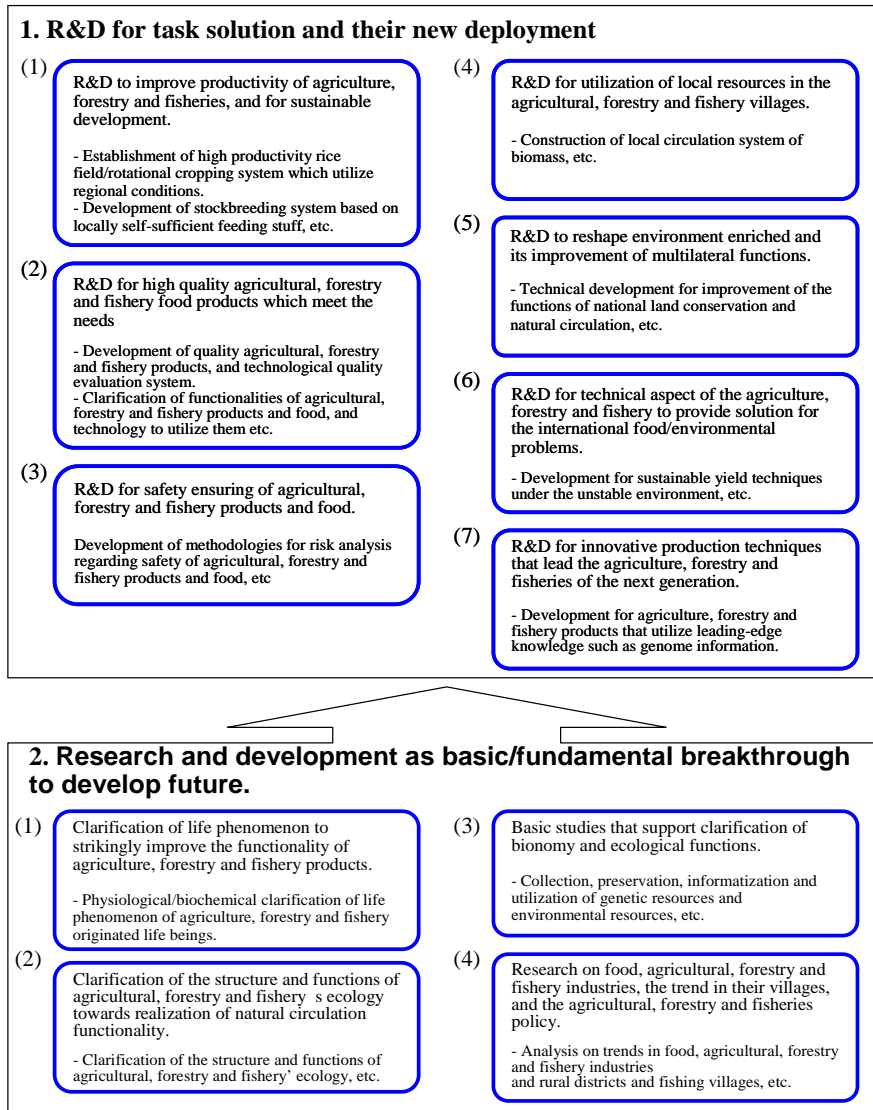
### 4.1 The promotion of researches along the emphasized targets.

In a basic research plan for the agriculture, forestry and fisheries, we have decided to place emphasis on:

- 1) 7 research and development fields as task solution and their new deployment;
- 2) 4 research and development fields as basic/fundamental breakthrough researches to develop future;

as future 10-year term targets, and to struggle with them.

Fig 4.1 Emphasized research targets for agriculture, forestry and fisheries.

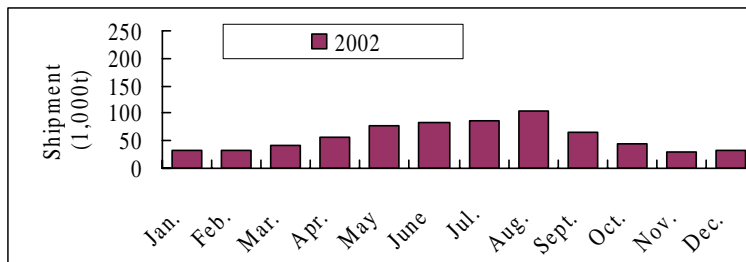


## 4.2 Examples of Research and Development

### 4.2.1 Research and Development for task solution and their deployment

#### (1) Cost reduction on large-sized steel frame green house.

Research and Development that makes it possible to supply vegetables all through the year.



Progress to a whole year supply of tomato by improvement of in-house cultivation technique and creation of new varieties.

Now tomato can be supplied all through the year which used to be a summer vegetable.



Improvement of the in-house cultivation technique played a great role



Introduction of new materials and a new method of construction greatly contributed to this significantly low cost green house. Building cost of the frame work of this house was reduced to about 1/2 of that of the conventional type house.



Significantly lower cost foundation engineering: "Inclined piping foundation engineering"



Reference:

-p.19 to 20, 67, 343 to 348, "The Developments Chronicle of Agricultural Technology in the Showa Era 2 (Wet Paddy Rice Growing)", [1993], Head Office for Agriculture, Forestry and Fisheries Technological Conference, Ministry of Agriculture, Forestry and Fisheries, Editing Committee for The Developments Chronicle of Agricultural Technology in the Showa Era, Institution of Agriculture, Forestry and Fisheries Technical Information.

-p.8, 17, 19, 20, 29, 36 to 37, 42, 44, 47, 50 to 53, "Technical Development that Changed the Agriculture and Further Efforts" [2006], Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF.

-p.10, "Research and Development Report for Agriculture, Forestry and Fisheries, No.6, R&D for rice plant to expand its usage" [2003], Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF.

- p.1 to 5, 8 to 9, 11 to 12, "Research and Development Report for Agriculture, Forestry and Fisheries, No.18, R&D for rice plant to expand its usage, (2006)", [2006], Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF.

- p.1, 3, "Research and Development Report for Agriculture, Forestry and Fisheries, No.19, New technology to efficiently advance the rotational cropping system between rice plant and other crops" [2007], Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF.

- p.2 to 4, 6, "Monthly Technological Conference, Extra number: No.49", [2005], Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF, Technical Policy Section, Head Office for Agriculture, Forestry and Fisheries Technological Conference, MAFF.