Transferred and Traditional Technology in Agriculture in Modern Japan

Hisashi Horio

Kobe University

1. An Outline of Technology Transfer from the 1870's to the 1910's

During the 230 years of seclusion preceding the modern era, a certain amount of agriculture-related literature was introduced from China to Japan. Farming equipment, the window winnow and rice husker mill, were also brought from China. Apart from this, though, Japanese agriculture was free from foreign influence. Japanese agricultural technology was developed whereby some uniquely Japanese characteristics evolved. At the beginning of the modern period, many Japanese watched Western civilization with keen interest, while also taking another look at every sector of the social system and production technology in Japan. Agricultural technology was one such sector to be reviewed. The transfer of Western agricultural technology was carried out under governmental supervision. This encounter with new technology, sometimes accompanied by a sense of inferiority and adoration, led to a negative view of indigenous methods. Many forgot that agriculture is closely related to the natural features and climate of a land and such a fundamental principle was completely forgotten by many. Consequently, this policy was impetuous and a complete failure. However, the plan itself did encourage a move to improve conventional methods.

The government followed a dual course: organizing expert farmers so as to improve agricultural production, and establishing an education system for transferring Western technology. Agricultural technology was developed by two leading bodies: expert farmers focused on empirical technology based on traditional farming methods, while the government researchers focused on theoretical technology based on transferred modern science.

Technology covering elemental matters and circumstances was successfully transferred. This resulted in the establishment of breeding, pest control, and soil and plant nutrition sciences. Each of these was based on transferred modern biology and chemistry.

Farmers were very much interested in a variety of rice paddies, and had selected different rice varieties developed by mutation and natural crossing. The names of rice paddy varieties are noted in farm literature written prior to modern times. However, progress was not made by the empirical body. The first phase of modern breeding and artificial crossing commenced in 1898. This artificial crossing program systematically followed the introduction of the newly understood Mendel's law (1902). A national experimental station for agriculture was established in 1893, along with some branches and provincial stations. Artificial crossing became the main task in experimental stations.[1] New varieties deemed fit were selected and distributed to provincial stations. After testing at the provincial stations these were utilized in farmers' fields after 1910. The pure line separation method was applied in 1910 after the introduction of Johansen's pure line theory (1903). The second phase of modern breeding thus began.[2]

Damage caused by insects, pests and disease is a major problem in a country like Japan where intensive farming is practiced. Insect and pest control had been developed prior to the modern period, and all diseases were thought to be caused by insects. Then plant pathology along with the concept of the pathogenic microbe was introduced to Japan.

However, the actual framework of the farming system did not change. Farming system technology, on account of its characteristics, could not be directly applied to Japanese agriculture.

This paper focuses on the direct and indirect influences of Western agricultural technology in Japan. The former is shown by referring to the activities of German teachers working at national agricultural schools, and the latter is shown by discussing views on tilling methods.[3]

2. Agricultural Schools and Foreign Teachers

2. 1 The Consolidation of an Education and Research System

No system existed for the propagation and expansion of Western agricultural technology in Japan. Two national agricultural schools were established during the first decade of the modern period: the Sapporo Agricultural School in 1875 and the Komaba Agricultural School in 1877.[4] The Sapporo school was established to

1 In the Kinki branch of the experimental station, Mendel's law was tested in rice paddies where the genetical characteristics, yield, quality, anti-pest methods, diseases, etc., were studied.

2 The first variety was developed with this method in 1914; variety *Riku-u* No. 20 derived from the traditional variety *Aikoku*. This method became the dominant method in the 1920's.

3 This paper is based on our book, Oka Mitsuo, Iinuma Jiro & Horio H. *Inasaku no Gijutsu to Riron* [Technology and Theory of Rice Cultivation] *Technology and Society of Modern Japan* I (Tokyo 1990).

4 Sapporo Agricultural School was the predecessor of the Agricultural College of Hokkaido Imperial University and the subsequent Faculty of Agriculture, Hokkaido University. Komaba

develop the province of Hokkaido. The Komaba school was established as a center for transferred and advanced agricultural science and technology. The government began by establishing national schools and training cultivating specialists. The actual consolidation of a propagation system was supervised by specialists graduating from these schools.

The Japanese government employed, at a ministerial level with high pay, ten agriculturalists as professors. Five American teachers were invited to the Sapporo school where the focus was on large-scale farming and five British teachers were invited to the Komaba school where common scale farming was the target. The British teachers were discharged after two years. The reason for their discharge cannot be confirmed, but officials and students at the school claim that they lacked enthusiasm[5]. After their discharge, German teachers were employed at the Komaba Agricultural School[6].

2.2 Soil Survey Program

Of the Germans, Max Fesca and Oscar Kerner were perhaps the most remarkable teachers and researchers. Max Fesca, a geologist, worked at the Komaba school from 1882 to 1892. At the same time he held a position with the National Institute for Soil Survey, where he directed a soil survey program. Traditional methods for soil classification were based on external appearance and an empirically and qualitatively defined potential for growing plants. A number of Japanese researchers and graduates of the Komaba school, worked under the direction of Fesca. They understood the novelty of new methods. One of them made a brief note on this:

> The soil survey method described by Professor Fesca was very novel at that time. Soil was generally classified by its original rock or geological system and surface soil. The survey report indicated the topography of the surveyed site, the physio-chemical property of each geological system and the relation between its properties and productive potential.[7]

Agricultural School was succeeded by the Agricultural College of the Tokyo Imperial University and the Faculty of Agriculture, Tokyo University.

5 One of the graduates at Komaba Agricultural School recalled; "British teachers did not give their attention to Japanese agriculture. We learned British agriculture itself and agricultural products at Liverpool Port." See Ueno Kyôiku-kai *Funatsu Denji Oh Hyôden* [Recollections of Mr. Funatsu Denji] (1907) 77.

6 Ando Enshu *Komaba Nôgakkô tou Shiryô* [Historical Documents of the Komaba Agricultural School] (1966) 37-87.

7 *Nôgyô-Gijutsu-Kenkyûsho 80 Nenshi* [80 Years History of The Institute for Agricultural Technology] (1973) 271.

Emphasis was placed on a systematic survey relating to cultivation and applications to actual farming.

Fesca and his assistants utilized phosphate absorption qualities when estimating soil properties. Most soil in Japan shows the properties of volcanic ash and has strong phosphate absorption properties. Therefore, there evolved the necessity for a phosphate fertilizer and the formulation of a method of application.[8] The application of phosphate fertilizer came to be theoretically recognized as one of the most important factors in improving agricultural technology in Japan and the development of the phosphate fertilizer industry. The industrial production of superphosphate began in 1888, using imported phosphate rock. In 1889, animal bone powder was also used.[9]

Upon completion of his work in Japan, Fesca published *Beitraege zur Kenntniss der japanischen Landwirtshaft* ('Allgemeiner Theil', in 1890, 277 pages and 43 figures, and 'Specielle Theil', in 1893, 929 pages and 412 figures). Japanese translations of these were published one year after each of the original works, and they had a great influence on many researchers and officials in Japan.

2.3 Fertilizer Nutrient Analysis

Oscar Kerner, an agricultural chemist, worked in Japan from 1881 to 1892. He directed fertilizer nutrient analyses of indigenous fertilizers. Kerner and his assistants analyzed nine animal-based fertilizers, fifteen plant-based fertilizers, four mineral-based fertilizers, two artificial fertilizers and eight other fertilizers. Remarkable work was also carried out on human waste (human excretion). Human waste was a very important fertilizer but had never previously been analyzed. Samples were collected from the waste pots of lavatories in farm houses, common residences, schools, and latrines at military bases. The highest value of fertilizer nutrient was detected in the samples from military bases where rich, nutritious food was served.[10] The analysis program lasted ten years and the results were published as *Nippon Hiryô Zensho* (Treatise on Japanese Fertilizers) (1888).

The German teachers brought with them to Japan the latest of knowledge from Germany. The superphosphate fertilizer industry had been established after the acceptance of Liebig's autotrophism of 1840. The three major nutrients theory

---

8 Oka Mitsuo, et al. *Inasaku no Gijutsu to Riron* 138-141

9 See Shimotani Masahiro *Nihon Kagaku Kôgyô Shiron* [History of Chemical Industry in Japan] (1982) 23-59, and also *Tagi Kumejiro* [Biography of Tagi Kumejiro] (1958) 23-76.

10 Saito Yukio *Nihon Nôgaku Shi* [History of Agricultural Science and Technology in Japan] (1968) 237-238.

was also generally applied. The chemical modernization of European agriculture was directly transferred to Japan.

However, results of chemical analysis were not useful without defining the limiting factor of yield (based on Liebig's law of minimum nutrient). Fertilizer response tests in rice paddy fields were carried out in the Komaba Agricultural School. The nutrient availability of a rice paddy was estimated through vegetation tests in the actual field.

Theoretical technology for rice cultivation was not covered by Western technology. This had to be newly established using modern theories introduced into Japan. Agricultural technology, lacking a technology for rice cultivation, could not be considered as agricultural technology in Japan. The establishment of modern agricultural technology in Japan was marked by the publication of two books on rice cultivation methods in 1887 and in 1889.[11]

The authors of the books were both educated at Komaba Agricultural School. Both books were the result of a series of studies and test programs carried out at that school.

3. Changing Views on Tilling Methods

3.1 Historical Background of the Japanese Plough[12]

The modernization of agricultural technology led to the development of an advanced plough for deep tilling. The conventional plough does not till deeply on account of its long and wide sole. Also, a fairly large portion of drawing power is lost due to adhesion resistance of the sole bottom to the soil. The conventional plough was introduced from northern China during the sixth and seventh centuries, and was used without any constructional or functional modifications. Originating in northern China, this plough was developed under dry farming conditions for shallow tillage.

The plough was not improved on in Japan from its introduction in ancient times until after the medieval times. This was due to the fact that non-fertilizing cultivation where deep tillage was unnecessary was normal practice. The year-round-watered paddy field supports a certain yield without fertilizer. The hoe was to become the dominant tilling tool in Japan.

---

11 Sako Tuneaki (Jomei) *Kairyô Nippon Inasaku Hô* [Advanced Methods for Japanese Rice Cultivation] (1887), and Yokoi Tokitada *Inasaku Kairyô Hô* [Methods for Improvement of Rice Cultivation] (1889).

12 Iinuma J. 'The Development of the Plough in Japan', *Tools & Tillage* 4.3 (Denmark)139-154, and Iinuma J. and Horio H. *Nôgu* [Farm Tools] (1976) 162-200.

During the 300 years preceding the modern period, the hoe, developed and modified to suit various soil conditions and operations, was used as the main tilling tool. In the sixteenth century, as part of the establishment of the feudal system, a land assessment program was established providing for the independence of lower and smaller farmers who were politically ranked as the leading force in agricultural production. Their typical tilling tool, the hoe, became the dominant tool used for all tillage and weeding.

3.2 Geneology of the Plough in Japan

The geneological flow of ploughs in Japan commences with the introduction of two types of ploughs from ancient China: the long-sole plough and the no-sole plough. This is shown in Figure 1. The development of the long-sole plough to the short-sole plough was the major flow of the geneology. The no-sole plough was independently developed into its advanced design during the first half of the nineteenth century. The design of the medium-sole plough was a combination of the long-sole and no-sole ploughs. Sharp turns in field operations became easier, while drawing stability could be retained. The short-sole plough was developed as an advanced design of the medium-sole plough over a number of decades after the appearance of the medium-sole plough. The short-sole plough is fundamentally different from the combined type in its design and balancing mechanism of forces acting on the plough body. Some functional and constructional features are shown in comparison in Table 1.

Figure 1. Geneology of Japanese Plough

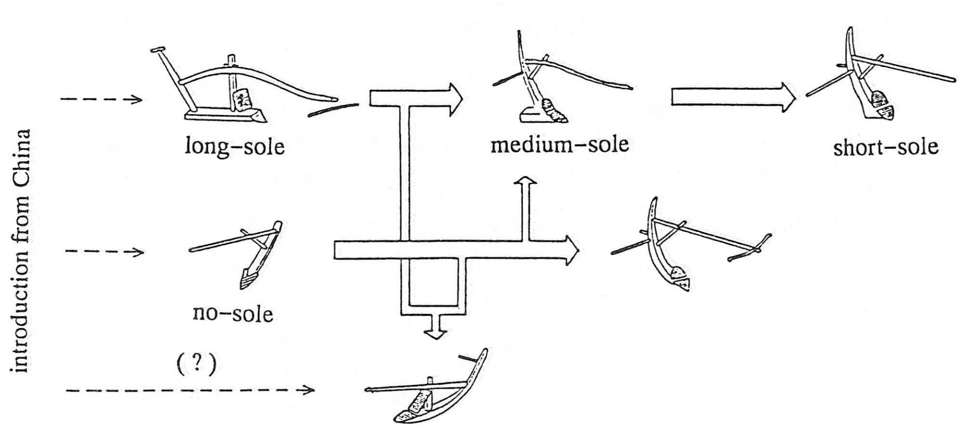

Table 1. Comparison of Plough Function

plough type	sharp turn	balance	tillage depth	soil turning
no-sole	easy	unstable	deep	not good
long-sole	hard	stable	shallow	fair
medium-sole	easy	stable	less deep	fair
short-sole	easy	stable	deep	good

3.3 The Modern Farming System and the Advanced Plough

During the 300 years when the hoe was the dominant tilling tool, the common view was that tilling with a hoe was best and that deep tillage with a plough was impossible. Virtually everyone in Japan believed this view.

When agricultural technology was reviewed, Western farm tools were copied and distributed under governmental supervision. This plan was a complete failure as the tools were too large for use in small fields and too heavy to be drawn by small Japanese horses and oxen. However, the plan did pave the way for improvements in conventional methods.

The view that tilling with a hoe is best was reconsidered from a Western point of view. A number of persons placed attention on tilling with a plough, while some recommended the use of an advanced no-sole plough being used in south-west Japan.

A new farming system for paddy fields of high productivity had been developed in south-west Japan. The new system incorporated advanced seed-preparing, weeding, fertilizing and drainage methods, and deep tillage with an advanced no-sole plough. The force acting on the no-sole plough was uni-dimensionally balanced, where balancing had to be continually regulated by the operator. The regulation of this balance required extreme skill on the part of the operator and exerted strain on the operator's body.

A number of farmers in south-west Japan had used the short-sole plough which was primitive and little more than a cross between the no-sole and long-sole ploughs. This short-sole plough had been modified and improved into an advanced plough with stable drawing, deep tilling and good soil turning. It was designated as one of the most important features of the new farming system encouraged by the landlord system in modern Japan. This system evolved by propagating the use of the modern short-sole plough and irrigating-draining control in the paddy field.

4. Concluding Remarks

The transfer of agricultural technology provided a theoretical base for modern breeding, pest control and soil and plant nutrient sciences to be founded on. This was the direct influence of the technology transfer. The development of an advanced plough was based on domestic knowledge and experience. The Western farm tools introduced into Japan did not directly influence the development of the plough, but the common view that deep tillage with a plough was impossible was quickly changed and exerted a deep impact on the introducing of unknown tools.

Chemical and biological methods in agricultural technology can be easily applied to actual production, independent of field-size, farming characteristics or social background. Physical and mechanical methods in agricultural technology are sometimes related to the individual condition of the soil, field, farming system or infrastructure. Both success and failure of agricultural technology transfer was determined by these basic characteristics.

Numerous specialists, graduates of Komaba Agricultural School and other national schools, worked as researchers and executive officials. Their wish was to develop rice production in Japan by applying new technology based on modern science. It was not their wish to develop traditional technology. Many of them felt that traditional ways would not lead the way to progress in production.

Successful results from technology transfers were applied at production sites and increased the yield of rice. Agricultural production cannot be supported by unit technology alone. High production is impossible without technology for a farming system. Many researchers felt that Western theory of farming systems could cover farming systems in east Asia and the rice production system in Japan. Many believed that the theory for improving the Japanese farming system could be found in Western agricultural technology. However, this was not to be. As time went by, many researchers working in universities and at experimental stations began to concentrate their studies on unit technology. Farming technology was not studied. Almost all the researchers switched their attention away from the farming system, and over to the study of unit technology. Fruitful results obtained from actual applications of transferred technology led many people to this conclusion. Few considered that agriculture is closely related to the natural features of the country it is practiced in.

Where, then, was farming system technology studied? Who studied it? The theory for a Japanese farming system already existed. It had been abundant in farm literature written two centuries before.[13] Farming system technology had

---

13 See Oka M. *Kinsei Nôgyô no Tenkai* [Evolution of Near Modern Agriculture] (1991) 99-240, and also *Koga-shunju* (1707) (reprinted in *Nippon Nôsho Zenshû* [Farm Literature in Japan] 4 (1980).

been sustained and developed by farmers and farming experts. A combination of unit technology, based on transferred technology, and traditional system technology had supported agricultural production.

Farming system technology was composed by synthesizing various factors and elemental technology. The concept of synthesis does not coincide with the idea of analysis. The theory for a Japanese farming system was not reflected as a science in the consideration of researchers trained in the idea of analysis. It was also not reflected as a noteworthy topic for their consideration.

In research conducted at national schools, government organizations and administrations, farming system technology was a matter of indifference, while too much importance was placed on the analysis of individual technology. This condition continued until the 1960's and 1970's. The author would like to cite one example of an unbelievable misunderstanding written in a technical paper: "We have no technology for a crop rotation system".[14] This technology, though, can be easily found in a developed form, noted in many agricultural works written 200 years prior to the present time. Did the researchers not know of this? Many of them were only interested in modern agricultural technology. This is perhaps another result of a 'successful' technology transfer 100 years ago.

---

[14] Kawai Kazuyuki 'Sôgô-teki Tochi Riyô no Kôsô to Kadai' [Conceptions and Ideas for Comprehensive Land-usage], *Nôgyô Gijutsu* [Agricultural Technology] 30.2 (1975) 89-92.