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Quality evolution and rice marketing policy in Japan

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Abstract

Rice variety improvement had been carried out to increase yield per hectare, Until the 1950s, Rounou varieties by diligent farmers and since the 1930s, MAF varieties were developed by the government.

The rice industry in Japan has recently changed drastically under the GATT Uruguay Round agreement, the announcement of the New Agricultural Policy and implementation of the New Food Law. In this circumstances, rice distribution channel has been deregulated and the independent distribution channel has become more significant. Consumer preferences to high quality rice has caused developments of local brands and new varieties of premium-priced rice.

Cluster Analysis and Hedonic Price Analysis are employed to investigate factors which cause price gaps among local rice brands. Those factors are divided into quality factors and non quality factors. Taste and cultivation characteristics are considered as quality factors. Taste element include 5 items, appearance, flavour, stickiness, softness and fragrance. Brand name power and marketing advantage are considered as non-quality factors.

The following points have been clarified :

- (a) Price differences among the local brands of rice are affected by the differences in both quality and non-quality factors.
- (b) As for rice quality factors, crop cultivation characteristics elements as well as the taste elements have impacts on price gaps. Among the taste elements, appearance, flavour and stickiness have significant effects on price gaps.
- (c) As for non-quality factors, Koshihikari varieties and Uonuma and Niigata Towns have great brand name power.

Supply responsiveness to premium prices was confirmed and has caused a concentration of certain varieties to be planted, which increase potential risks of a major crop failure and limits improvements in the efficiency of labour and farm machinery use. So, breeding efforts to develop high quality rice varieties with different growing periods are desirable.

Keywords

- Cluster Analysis, Hedonic Price Regression, Food Control Law, New Food Law, Local Brand Rice, Voluntary Distributed Rice, Koshihikari
- Japan

History of rice variety improvement in Japan

In the history of Japan, rice has been the main staple food until recently. Since the Edo Period, successive efforts have been made to improve the quality of rice varieties. Generally speaking, there were two types of variety improvements. One type was made through trial and error by diligent farmers, called "Rounou". The other was made by artificial crossbreeding at public experimental stations. In this process, the major targets of variety improvements were the increase of yield per hectare and the improvement of tolerance to unfavourable weather conditions. Figure 1 shows the historical development process of rice variety improvements in Japan. In the early stages of rice variety improvement, the superior varieties of Jinriki, Aikoku and Kamenoo had developed and spread across the nation. Among these, the Jinriki variety was selected by Jujirou Maruo, a farmer in Hyogo Prefecture, western Japan, which contributed to a drastic increase of the yield in western to central Japan. On the other hand, the Kamenoo variety was selected by Kameji Abe, a farmer in Yamagata prefecture, northern Japan, and was tolerant to the cold weather. Those were selected as the superior varieties in those days by the diligent farmers' efforts through trial and error and have been called "Rounou" variety.

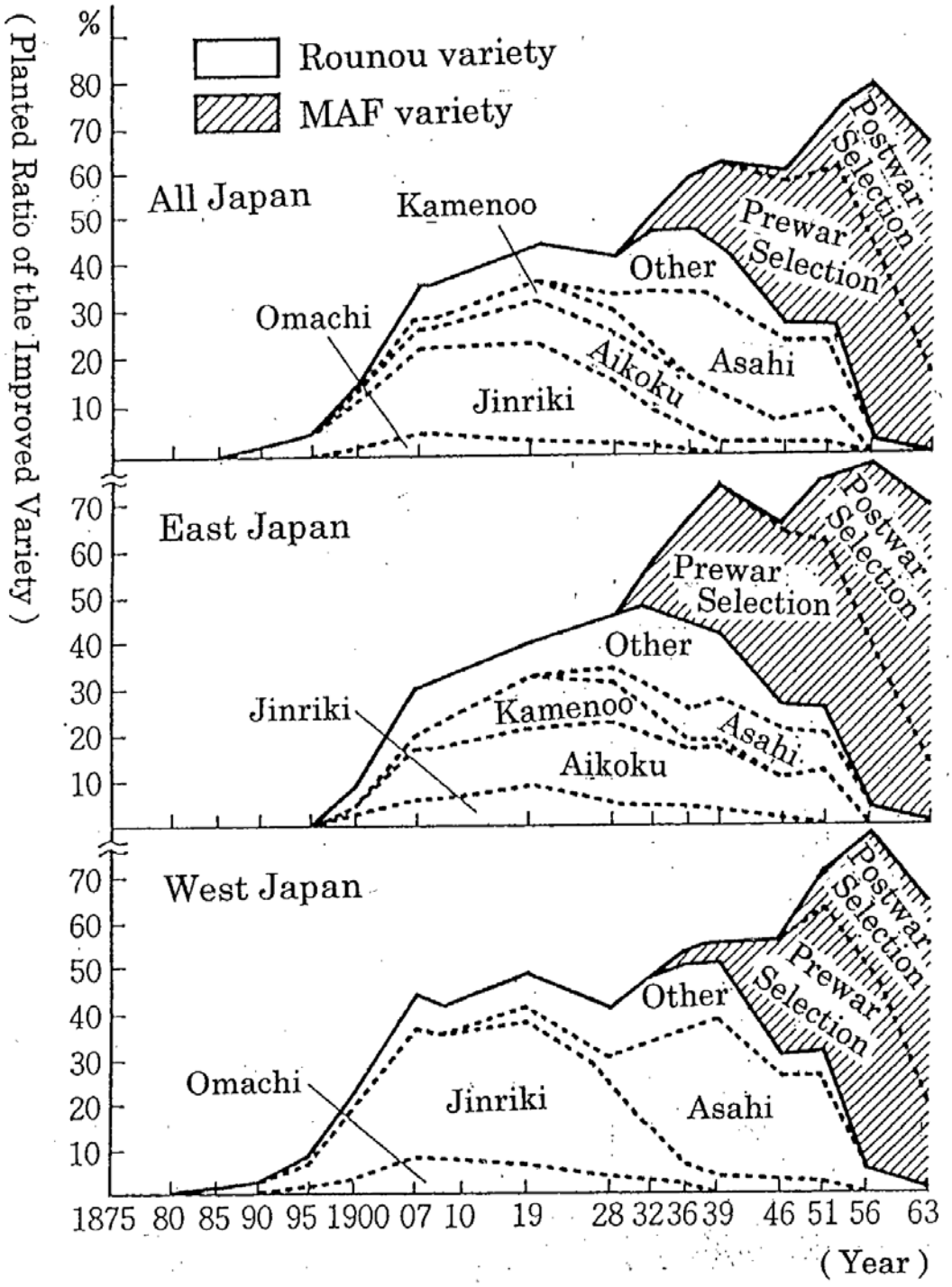
In the early economic development stage, it has been confirmed that increases in the average yield per hectare corresponded with increases in share of these "Rounou" varieties planted. The Rounou varieties were introduced first in western Japan and then diffused into eastern and northern Japan gradually.

In 1904, the National Agricultural Experimental Station was established in the Kinki district, where several remarkable new varieties were developed through scientific research. However, collaboration between this station and local research organizations was not well developed. And so, these varieties did not spread widely because they were not adapted to local growing environments such as weathers etc.

It was after the Ministry of Agriculture and Forestry (MAF) established the designated experiment system in 1926 that the results from modern scientific research could contribute greatly to increasing agricultural productivity. Under this system, Japan was divided into several ecological zones and a designated experimental plot was allocated in each ecological zone. As the core of the system, the National Agricultural Experimental Station conducted crossbreeding and selected hybrids to the third generation while each designated experimental plot carried out the subsequent selection, genetic stabilisation and adaptation experiments and determined superior varieties in the region. Then, experimental stations at the prefectural level carried out validity tests of these superior varieties and determined the recommended varieties for their prefecture, proliferated and diffused them. This system for variety improvement is considered to be the most advanced organisation of its kind in the world in those days. This system was adopted for wheat first and then for rice and other crops later. It is well known that the variety "Mexican dwarf wheat", the origin of "the green revolution" was created based on the variety "MAF10" which was developed under this designated experimentation system in this way. This MAF variety had spread widely since the mid-1930s.

The rice varieties which were a major part of government distribution rice under the "Food Control Law" had been these "MAF" varieties.

Figure 1 : History of Rice Variety Improvement



Rice Policy Development

Policy development around the "Food Control Law"

Since the "Food Control Law" was enacted in 1941, the supply of staple foods such as rice and wheat have been stable. Before the World War, the rice market in Japan had been extremely unstable and a riot broke out due to rice shortages and skyrocketing rice prices in 1918 just after the First World War. So, the government enacted the Rice Law. Under this law, the government controlled the rice market by purchasing certain amounts of rice from the market and selling them to consumers at lower prices. This was " partial administrative control " of the rice market. The " Rice Control Law " was enacted in 1933, establishing a kind of price stabilisation system, in other words, an "indirect control system". Under this system, the government bought rice from the market when its price fell down to a level lower than the admissible minimum and sold the rice from its rice stock to the market when the rice price rose to a level higher than the admissible maximum.

During the Second World War, the "Food Control Law" was enacted. This was a so called "direct control" system with which the government tried to manipulate the supply & demand, price, distribution and trade of all of the staple foods. Before the mid 1960s, when rice continued to be lacking, the major target of the "direct control" of the "Food Control Law" was to raise the producer's rice price through rice production control without evoking criticism from the tax-payer. For this purpose, the government paid a higher rice price to producers and sold rice at a lower price to consumers and offset the losses from the treasury.

However, rapid economic growth in Japan caused a shift of consumer demand from rice to non-rice foods while production growth spurred by the high producer's rice price brought huge surpluses of rice. Reflecting this situation, the Food Control Law was revised in 1969, and the "Voluntary Rice Distribution System" was started. Under this system, private organizations have also been allowed to distribute rice separately from government distribution rice. Moreover, since 1971, a policy of rice production reduction had been implemented and the government purchasing system with rice production control has been adopted.

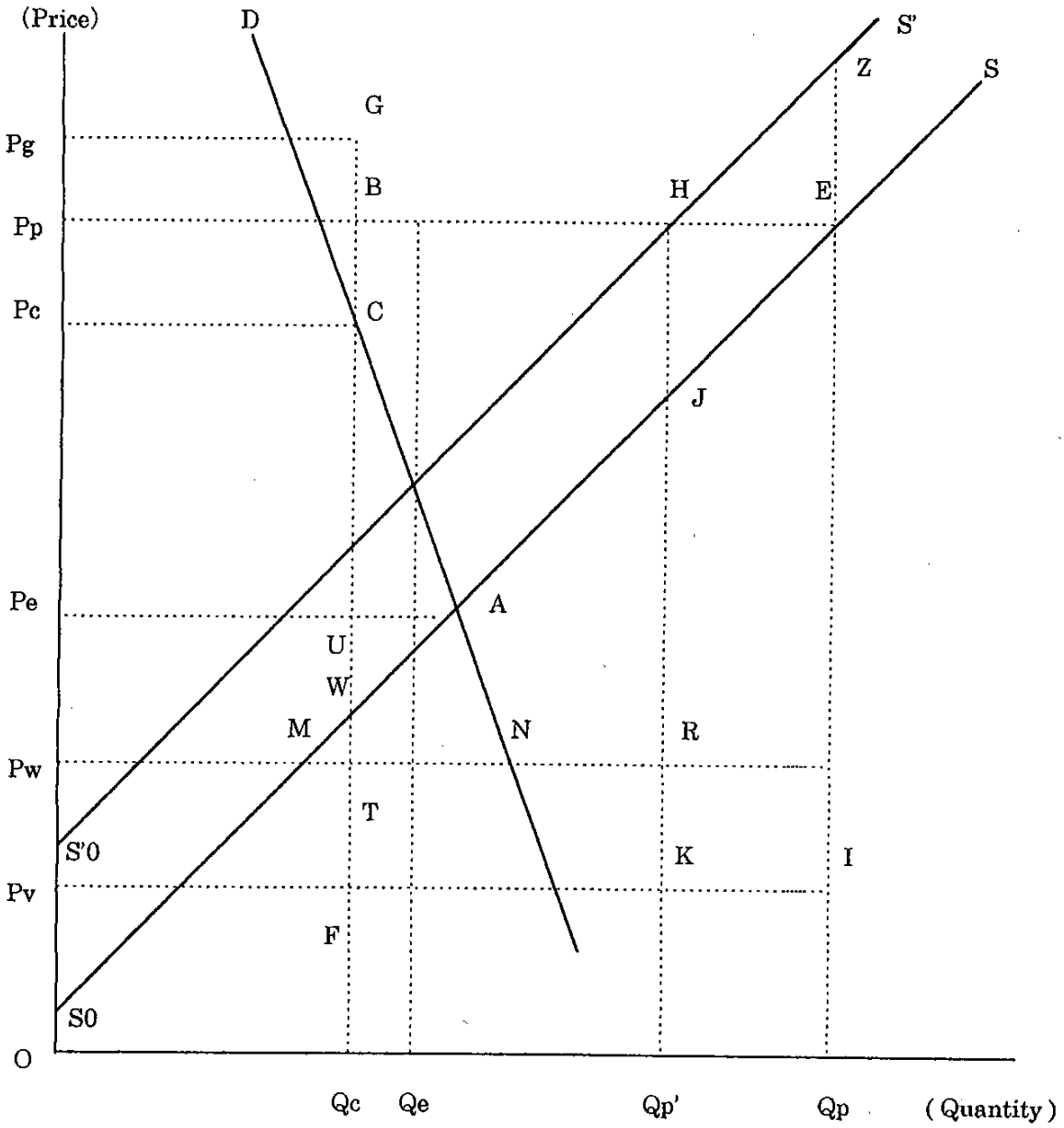
Since then, decreasing rice surplus and adjusting to the conversion from quantity to quality in consumer demand were major targets for the government. Therefore, the government had to adopt the introduction of price differences (discrimination by brand), charging premiums for high quality varieties of rice. Along with this policy, from 1978 for 9 years, the government strictly enforced the Paddy Field Reduction Policy and the paddy field diversification scheme by subsidising rice farmers who converted production from rice. In 1981, the system of rice distribution control by the government was abolished. Also, the rice dealer licensing system and distribution control were deregulated widely. And in 1984, the system of rice for non-major use was started in order to resolve inconsistency between rice quality gaps and the Food Control Law.

During this period, the discrepancy between production and consumption had caused structural surpluses because the rice price support policy had been maintained basically to secure incomes for rice farmers. Since 1987, the "Rice Farming Establishment Measure" has been promoted in order to enlarge the farm management size and to reduce rice surpluses through production restriction and crop conversion. At the same time, government rice purchasing price has been switched from raising the producer price to lowering it for the first time and the income support for farmers has shifted substantially from rice price policy to structural policy. Figure 2 shows the rice market system and price policy under the Food Control Law.

Furthermore, the share of voluntary (independently) distributed rice has become dominant form of distribution and share of government purchasing has declined. In these circumstances, as the black market and illegal distribution of rice had expanded, the lawsuits against the Food Control Law such as the case of Ogata village had occurred very often. In this process, the significance of the Food Control Law had been lost gradually. In 1990, the organisation for price formation of voluntary distributed rice was established and the rice auction system was started although the price was kept to between upper and lower limits. In 1992, the New Agricultural Policy which showed the new direction of agricultural policy was announced, making explicitly clear that Japanese agriculture and agricultural policy, including rice, had to accept the introduction of market mechanisms and conform to the international movement toward free trade.

In December, 1993, minimum access, even for rice, was required for 6 years under the agreement of the GATT Uruguay Round and rice importation has been carried out since 1995. Due to these drastic changes in the rice economy in both the domestic and international environment, the reform of the rice distribution system was called for by the Agricultural Policy Council in 1994. At this point, the Food Control Law which had been maintained for more than half a century since 1942, was replaced by the "Law for the Stabilisation of Demand & Supply and the Price of Staple Foods", otherwise known as the "New Food Law", enacted in December 1994 and enforced in November 1995.

Figure 2 : Rice Market & Rice Price Policy under the Food Control Law



Pw : international price
Pe : domestic price under the free trade
Pp : producer's price
Pc : consumer's price
M : production equilibrium point
N : consumption equilibrium point
A : market equilibrium under the free market system
C ; consumption equilibrium point under the price support system
Qc : demanded quantity under the price support system
Qe : supplied quantity under the free market system
Pg : government cost price
QcQe : excess supply in the short run
GPgPcC : fiscal deficit due to Food Control System
E : production equilibrium point under the price support system
QcQp : excess supply in the long run
Pv : desposition price
EBFI : government loss due to rice disposition
QpQp' : production curtail (set aside)
H : production equilibrium point under the production control system
QcQp' : excess supply under the production control system
HBFK : government loss due to rice disposition under the production control system
EZHJ : set aside subsidy
(total government cost under the set aside policy) = GPgPcC + HBFK + EZHJ
(consumers' surplus loss based on international price) = CPcPwN
(consumers' surplus loss based on domestic price) = CPcPeA
(producer surplus) = HPpSOJ + EZHJ

(producers' surplus gain under the free market system based on international price) = HPpPwMJ + EZHJ
(producers' surplus gain under the free market system based on domestic price) = HPpPeAJ + EZHJ
(net loss of social welfare based on international price) = JWFK + CTN + WMT
(net loss of social welfare based on domestic price) = JWFK + CWA

Targets of the ' new food Law ' and problems

The purpose of the New Food Law is the rationalisation of the distribution system through the introduction of market mechanisms, the deregulation and the formation of firm organisation for rice production by producer's initiatives as well as the stabilisation of price and the supply and demand relation for rice.

The main differences between the Food Control Law and the New Food Law are as follows. The main goals of the former are :

(i) to adjust the total supply and demand by national regulation such as production control (set-aside) and trade policy.
(ii) Government distribution of rice is the core of the system although non-government distribution of rice has become significant recently.
(iii) The government stabilises production and the consumers' home economy.
(iv) The government controls the licensing of distributors and wholesalers, and the marketing from the producers to government.

On the other hand, in the New Food Law :

(i) government regulation of rice distribution is to be decreased in order to vitalise the distribution, encourage active management by the producers and to stabilise the supply of rice for consumers.
(ii) Set-aside (rice paddy conversion) is carried out only by producers' own will while the government adjusts total supply and demand through set-aside and reserve stocks following the basic plan.
(iii) Non-government distribution rice is to be the core of distribution and operation of government distribution rice is limited to reserve stock and importation through minimum access.
(iv) The price should be formed reflecting the actual demand & supply situation through the auction of non-government distribution rice, and these price trends are reflected by the governmentally distributed rice.
Figure 3 shows the comparison of the old and new rice distribution channels under the two laws.

The above mentioned are the major difference between the two laws. However, the New Food Law has the following problems.

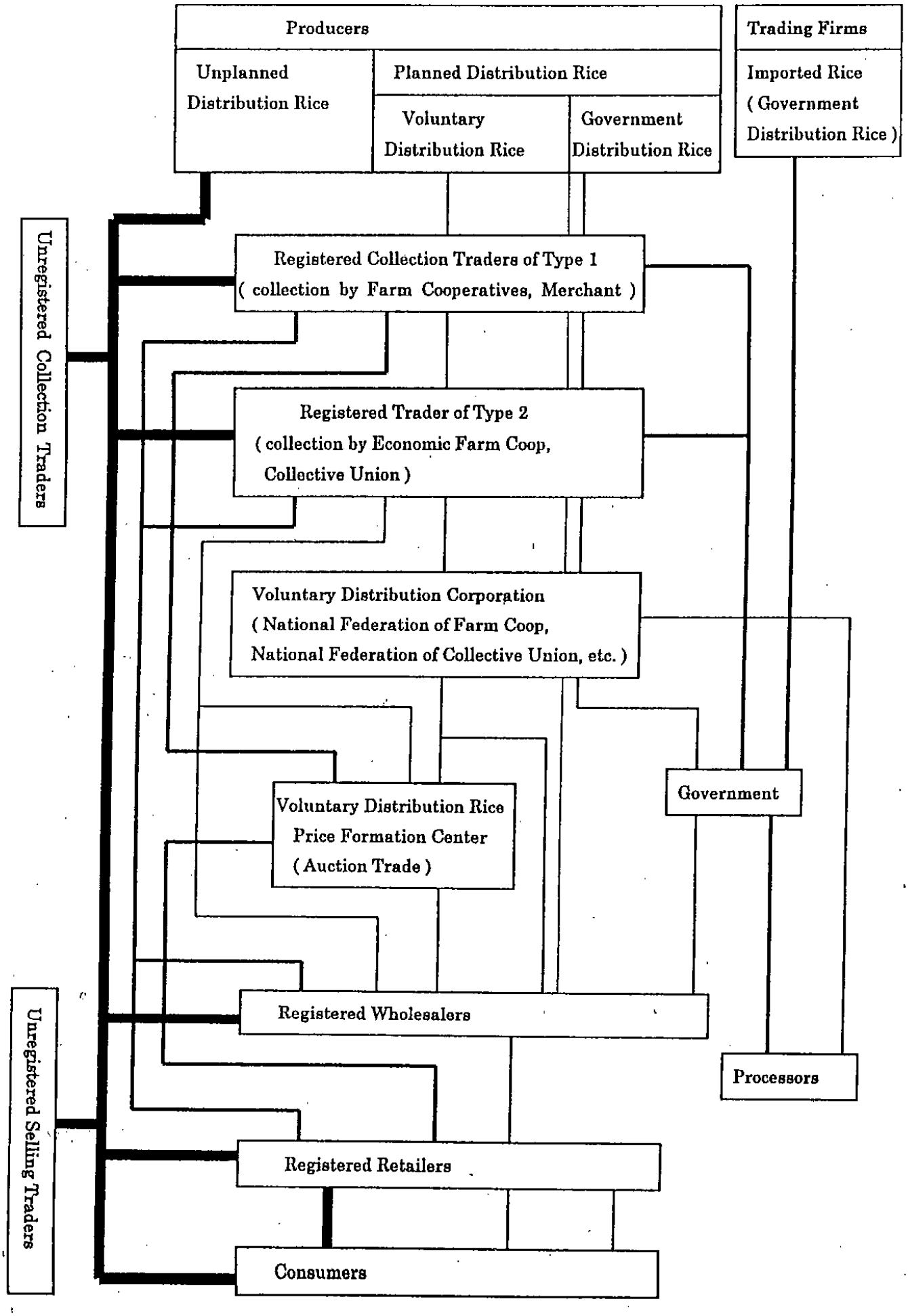
(i) The adjustment of demand & supply may not function sufficiently because the share of rice which is distributed outside the scheme of distribution by registered distributors tends to increase.
(ii) The reserve stock of rice is planned to be released to the market to lower the price when the price is high. But there is no guarantee to keep the price above the admissible bottom level when the rice price declines due to oversupply because of import increase as minimum foreign access increases or when a good crop is realised.
(iii) The partial deregulation of set-aside has both merits and demerits. If producers try to grow rice freely the rice price has more risk of decline. So, it is forecast that it will become hard to control production through the set-aside policy.

Because of changeable factors such as risks from the fluctuation of the harvest yield, instability due to the reorganisation of the rice distribution business and the change of fundamentals of the Japanese economy, the effects on the production, distribution and consumption of rice should be very big. At the moment, the several problems (limitations) have been pointed out on the voluntarily distributed rice market under the New Food Law.

- (1). Limitation of the quantity traded. There is maximum limits for the quantity of rice tradein the auction price system (25% of supplied quantity of each local brand rice was auctioned in 1996).
  So, only limited effects can be expected to reflect the supply & demand situation
- (2).Limitation of the rice brand traded. One agricultural cooperatives can trade only one local rice brand for the same variety of rice within its organisation.
- (3). Limitation of the frequency of the market trades. Auction was carried out only 8 times in 1996. Now it is proposed to increase the frequency of auction trade into 10 times a year.
- (4). Limitation of price fluctuation bands. In order to avoid the price instability. Price change are not allowed to be more than 7% of the price level in the preceding auction trade at the moment. Now it is argued that it should be enlarged to 10%.

These restrictions has been limiting the functions of the auction trade to clear the market and realise the reasonable price reflecting the actual situation of both supply and demand sides.

Figure 3 : Comparison of the Old & New Rice Distribution Channels


Producers
Unplanned Distribution Rice
Planned Distribution Rice
Voluntary Distribution Rice
Government Distribution Rice
Trading Firms
Imported Rice (Government Distribution Rice)
Unregistered Collection Traders
Registered Collection Traders of Type 1 (collection by Farm Cooperatives, Merchant)
Registered Trader of Type 2 (collection by Economic Farm Coop, Collective Union)
Voluntary Distribution Corporation (National Federation of Farm Coop, National Federation of Collective Union, etc.)
Government
Voluntary Distribution Rice Price Formation Center (Auction Trade)
Unregistered Selling Traders
Registered Wholesalers
Processors
Registered Retailers
Consumers

Quantitative Evaluation of price differentials & quality gaps between local brands of rice

Background

Since the introduction of the "New Food Law" in 1995, price gaps between local rice brands has rapidly been enlarged. According to the report by Kawaguchi (5), the following has been pointed out. Concretely speaking, the price gaps between the highest and lowest prices of rice was 1.4 times at the beginning of the "voluntary distribution (non-government distribution channel) rice system. This gap was about 1.6 times at the first trade after the implementation of the "New Food Law". Moreover, this gap has enlarged to be more than 1.9 times , only 1 year later.

In this way, price gaps between rice local brands is large. It is not clear whether factors which determine these price gaps are has been consistent as the gaps has enlarged. Also, it has not been clarified whether the price gaps between rice brands are derived from differences in the quality of rice itself or by factors other than quality.

As for the difference in the quality of rice itself, taste factors such as appearance, flavour, fragrance, stickiness and softness are considered to be factors which affect the price gaps. Other than this, characteristics such as adaptability to cold weather can also affect the price gaps between rice brands as they affect the production cost. As for factors other than rice quality, the name brand power of certain Production areas and varieties is considered among factors which determine the price gaps.

In this paper, how these factors affect the price gaps of the voluntarily (independently) distributed rice (i.e. non-government distribution channel rice) among the rice produced at different places is investigated quantitatively. Methodologies employed are (i) cluster analysis and (ii) regression analysis based on the Hedonic approach.

Factors which determine the price of local brands of rice

As the factors which determine the prices of rice brands based on production area, rice quality, production cost and advantages in marketing are considered. Other determining factors are celebrity and credibility of the rice brand, which are referred to as "brand power" in this paper. In other words, the brand power is defined as the remaining part of total price determining factors from which the rice quality, production cost and marketing advantage are deducted.

Regression analysis is conducted based on these determining factors. However due to the limitation of available data, it is very difficult to measure brand power numerically and use them as variables in the normal regression analysis. In order to avoid this problem, cluster analysis is applied to understand general characteristics of each rice brand. Moreover, based on the results, certain rice brands which have brand power are selected and these are used as dummy variables in the regression analysis. Among the variables used in this estimation, the 5 variables of appearance, smell, flavour, stickiness and softness were measured in terms of 5 stages and all others were treated as dummy variables.

Cluster analysis and Hedonic Regression approach

Cluster analysis is used to understand the overall images of price gaps between rice brands distinguished by production area according to the similarities among each rice brand specific to production areas. However, in this methodology, the detailed factors of price gaps among rice brands are not identified and so we have to conjecture them. On the other hand, Hedonic Regression approach can clarify the significance of each variable as the determining factors of price gaps. However this method cannot deal with factors which cannot be quantified. So, I try to make use of the merits of both methodologies in this paper.

Results of Cluster Analysis and their investigation

In this paper, I define that there is singularity when separate single clusters are found without overlapping each other. The results of grouping local brands of rice with respect to prices are shown in Figure 4 for the Tokyo market and Figure 5 for the Osaka market.

Figure 4 : Similarities among rice local brands (Tokyo, Price)

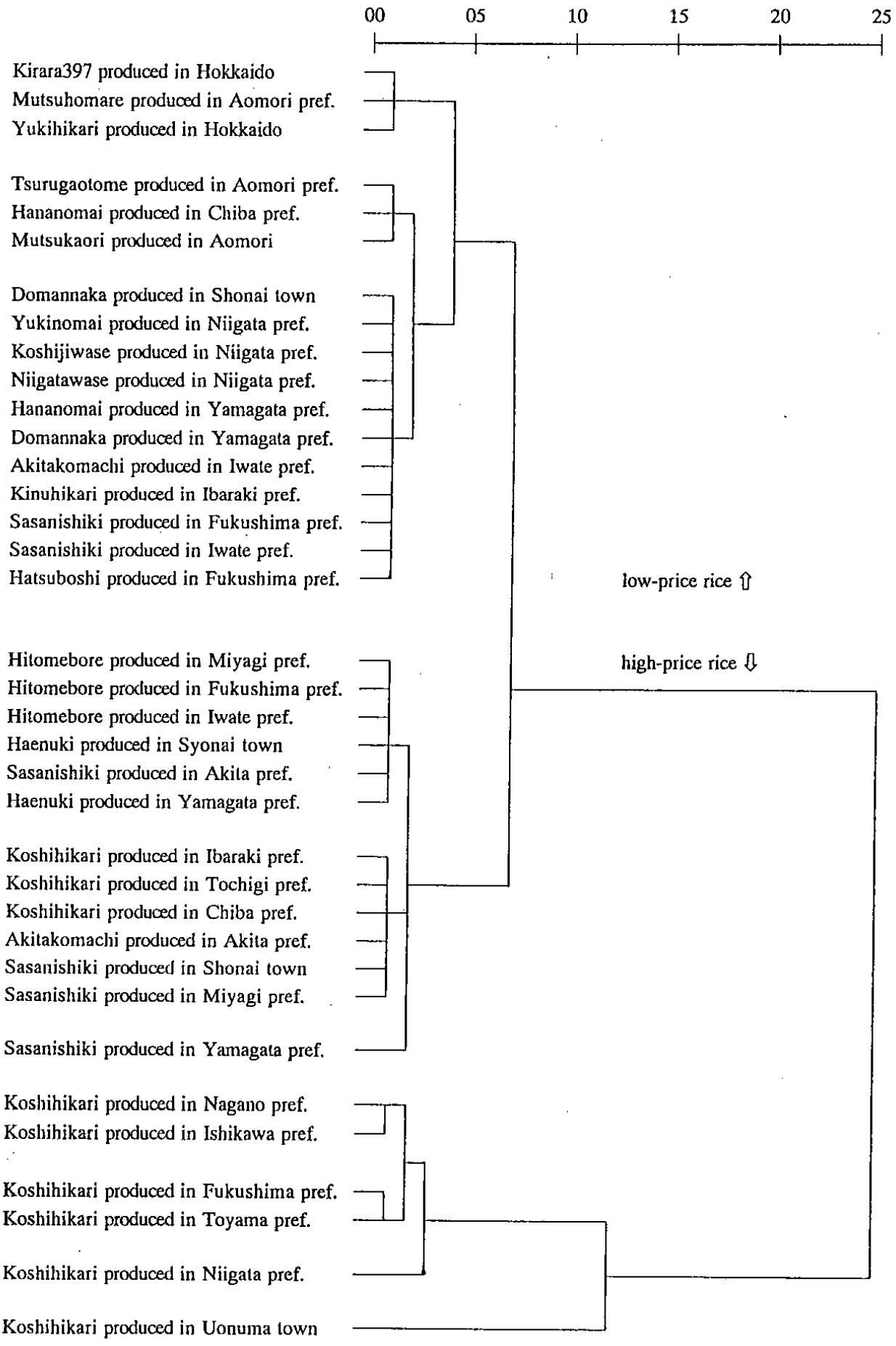
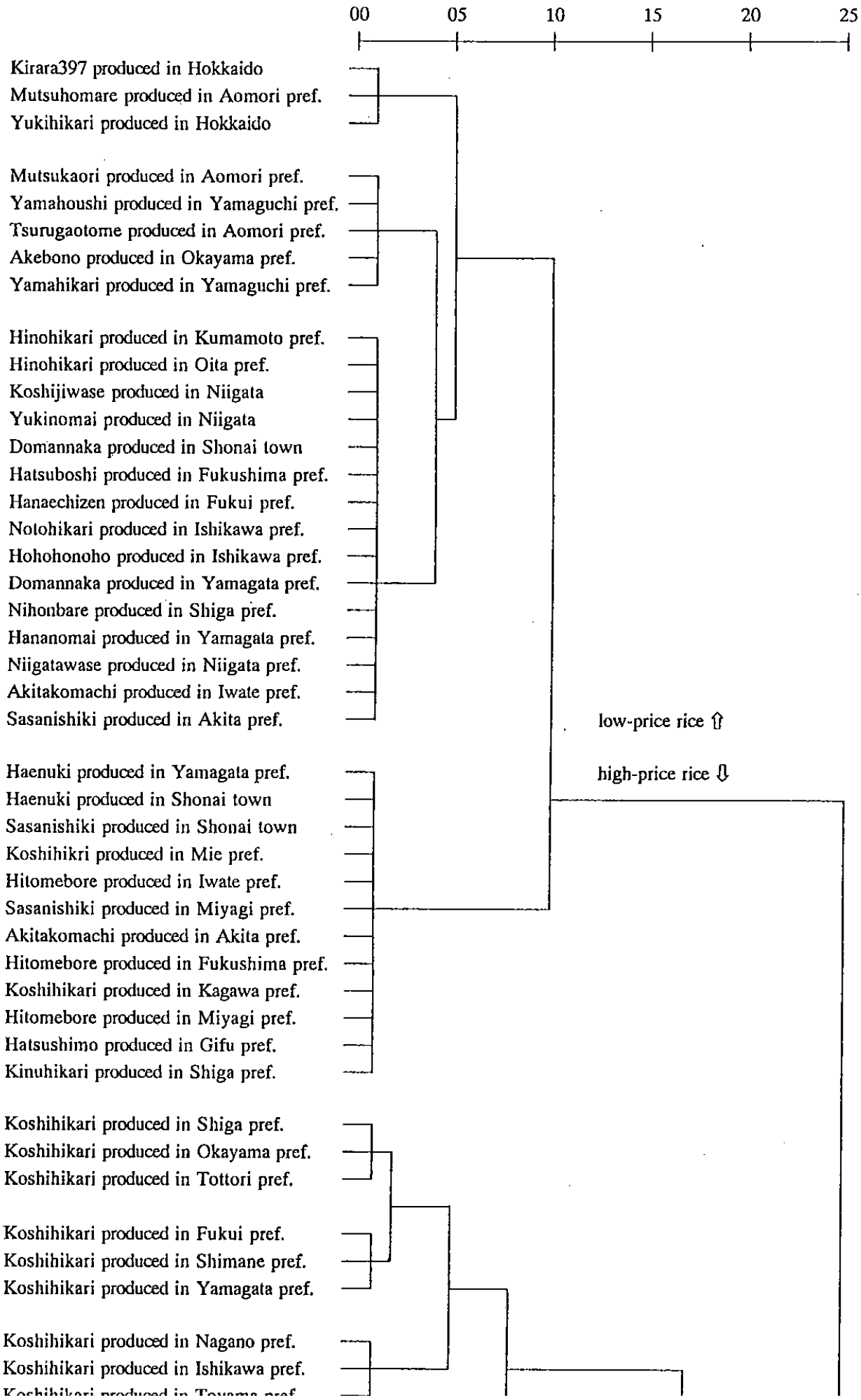


Figure 5 : Similarities among rice local brands (Osaka, Price)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Kirara397 produced in Hokkaido
Mutsuhomare produced in Aomori pref.
Yukihikari produced in Hokkaido
Mutsukaori produced in Aomori pref.
Yamahoushi produced in Yamaguchi pref.
Tsurugaotome produced in Aomori pref.
Akebono produced in Okayama pref.
Yamahikari produced in Yamaguchi pref.
Hinohikari produced in Kumamoto pref.
Hinohikari produced in Oita pref.
Koshijiwase produced in Niigata
Yukinomai produced in Niigata
Domannaka produced in Shonai town
Hatsuboshi produced in Fukushima pref.
Hanaechizen produced in Fukui pref.
Notohikari produced in Ishikawa pref.
Hohohonoho produced in Ishikawa pref.
Domannaka produced in Yamagata pref.
Nihonbare produced in Shiga pref.
Hananomai produced in Yamagata pref.
Niigatawase produced in Niigata pref.
Akitakomachi produced in Iwate pref.
Sasanishiki produced in Akita pref.
low-price rice ⇧
high-price rice ⇩
Haenuki produced in Yamagata pref.
Haenuki produced in Shonai town
Sasanishiki produced in Shonai town
Koshihikri produced in Mie pref.
Hitomebore produced in Iwate pref.
Sasanishiki produced in Miyagi pref.
Akitakomachi produced in Akita pref.
Hitomebore produced in Fukushima pref.
Koshihikari produced in Kagawa pref.
Hitomebore produced in Miyagi pref.
Hatsushimo produced in Gifu pref.
Kinuhikari produced in Shiga pref.
Koshihikari produced in Shiga pref.
Koshihikari produced in Okayama pref.
Koshihikari produced in Tottori pref.
Koshihikari produced in Fukui pref.
Koshihikari produced in Shimane pref.
Koshihikari produced in Yamagata pref.
Koshihikari produced in Nagano pref.
Koshihikari produced in Ishikawa pref.

Similarly grouping results of local brands of rice on taste are shown in Figure 6 for the Tokyo market and in Figure 7 for the Osaka market.

Figure 6 : Similarities among rice local brands (Tokyo, Taste)

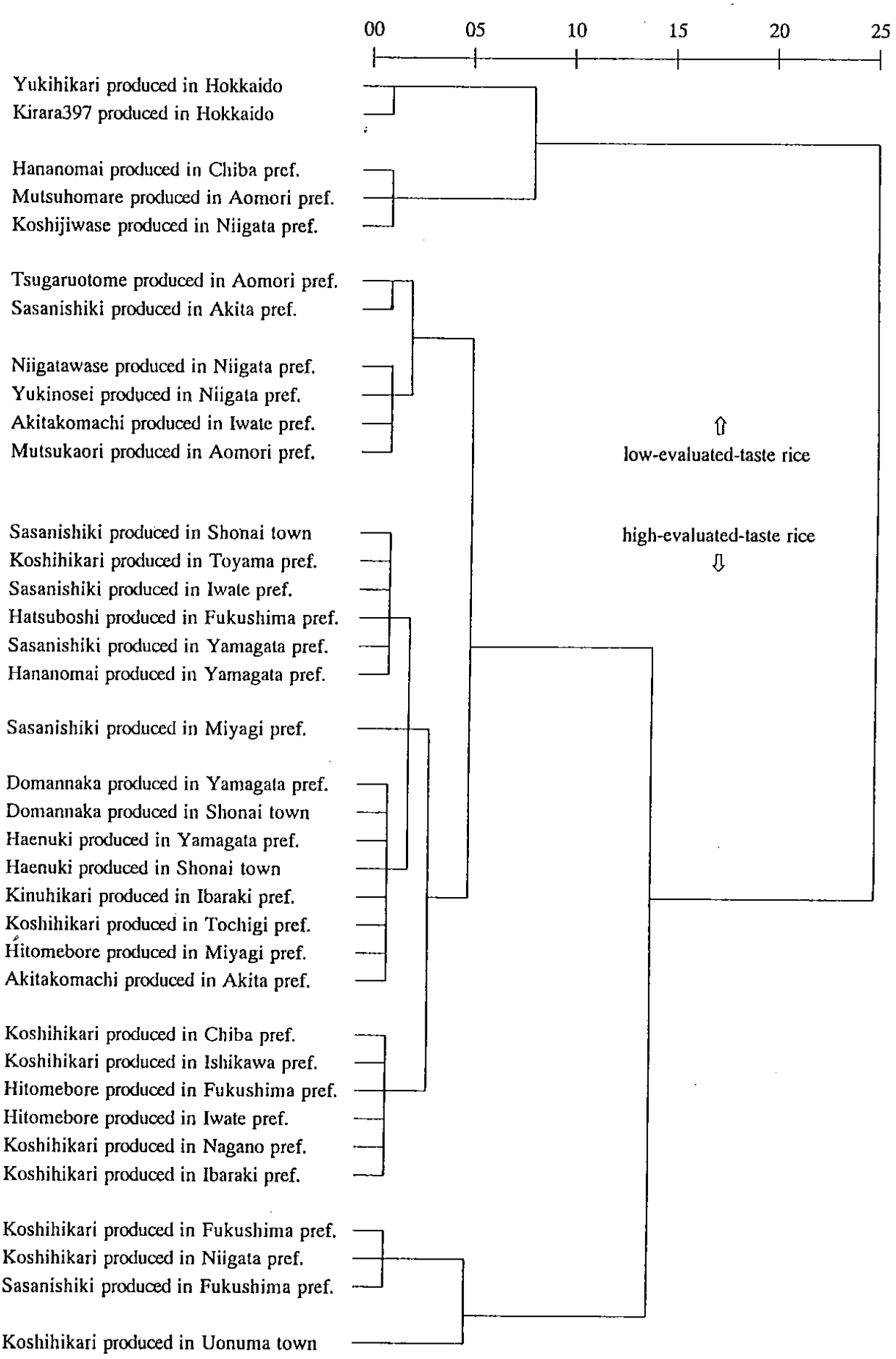
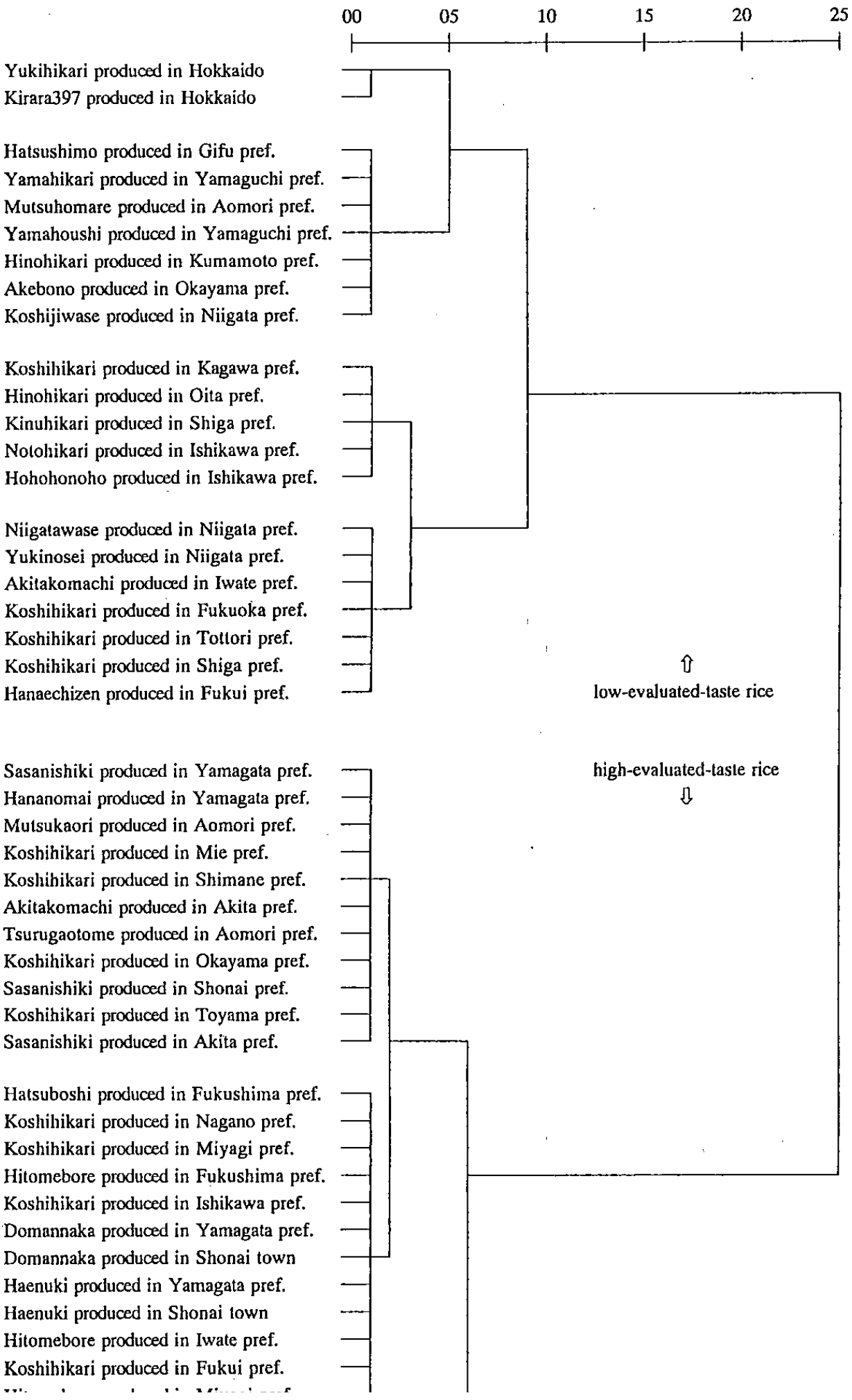


Figure 7 : Similarities among rice local brands (Osaka, Taste)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Yukihikari produced in Hokkaido
Kirara397 produced in Hokkaido
Hatsushimo produced in Gifu pref.
Yamahikari produced in Yamaguchi pref.
Mutsuhomare produced in Aomori pref.
Yamahoushi produced in Yamaguchi pref.
Hinohikari produced in Kumamoto pref.
Akebono produced in Okayama pref.
Koshijiwase produced in Niigata pref.
Koshihikari produced in Kagawa pref.
Hinohikari produced in Oita pref.
Kinuhikari produced in Shiga pref.
Notohikari produced in Ishikawa pref.
Hohohonoho produced in Ishikawa pref.
Niigatawase produced in Niigata pref.
Yukinosei produced in Niigata pref.
Akitakomachi produced in Iwate pref.
Koshihikari produced in Fukuoka pref.
Koshihikari produced in Tottori pref.
Koshihikari produced in Shiga pref.
Hanaechizen produced in Fukui pref.
⇧
low-evaluated-taste rice
high-evaluated-taste rice
⇩
Sasanishiki produced in Yamagata pref.
Hananomai produced in Yamagata pref.
Mutsukaori produced in Aomori pref.
Koshihikari produced in Mie pref.
Koshihikari produced in Shimane pref.
Akitakomachi produced in Akita pref.
Tsurugaotome produced in Aomori pref.
Koshihikari produced in Okayama pref.
Sasanishiki produced in Shonai pref.
Koshihikari produced in Toyama pref.
Sasanishiki produced in Akita pref.
Hatsuboshi produced in Fukushima pref.
Koshihikari produced in Nagano pref.
Koshihikari produced in Miyagi pref.
Hitomebore produced in Fukushima pref.
Koshihikari produced in Ishikawa pref.
Domannaka produced in Yamagata pref.
Domannaka produced in Shonai town
Haenuki produced in Yamagata pref.
Haenuki produced in Shonai town
Hitomebore produced in Iwate pref.
Koshihikari produced in Fukui pref.

As shown in Figure 4 and Figure 5, in the Cluster analysis based on prices, the Koshihikari variety produced in Uonuma Town forms a single cluster in both Tokyo and Osaka markets when we classify total clusters into more than three clusters. Therefore the Koshihikari variety produced in Uonuma town has a prominent singularity.

On the other hand, in the Cluster analysis based on taste evaluation, as shown in Figure 6 and Figure 7, Koshihikari produced in Uonuma show singularity in comparison with other brands of rice produced in other areas. However, until I classify total clusters into more than 6 clusters in the Tokyo market and more than 8 clusters in the Osaka market, Koshihikari variety produced in Uonuma does not form a single separate cluster. In this way, in the case of cluster analysis based on taste evaluation, Koshihikari variety produced in Uonuma, does not show any prominent singularity which was shown in the case of cluster analysis based on price. Similar tendency is observed for Koshihikari produced in Niigata Town.

So, we can say that as for Koshihikari produced in Uonuma and Niigata Town, price gaps among rice brands are bigger than differences in taste evaluation. Figure 8 shows a map of major brand rice producing areas.

In the next, the results of Cluster analysis are shown in Table 1 for the Tokyo market and in Table 2 for the Osaka market. In both Tokyo and Osaka markets, the 4 brands of rice of Hananomai produced in Yamagata town, Domannaka produced in Yamagata town, Domannaka produced in Shonai town and Hatsuboshi produced in Fukushima town are considered to be rice brands of low price and highly evaluated taste. So they are favourable rice for consumers to buy. Also the 3 brands traded only in the Tokyo market (Sasanishiki produced in Iwate Prefecture, Sasanishiki produced in Fukushima Prefecture and Kinuhikari produced in Ibaraki Prefecture) are favourable for consumers to buy. As for Sasanishiki produced in Akita Prefecture, evaluations in both markets are opposite due to the effects of differences in quantity traded in each market. It is favourable for consumers to buy in the Osaka market but unfavourable for consumers to buy in the Tokyo market.

In both Tokyo and Osaka markets, all local brands of rice in the Koshihikari producing areas are classified as high price rice. Most local brand rice of Koshihikari variety are of high price and highly evaluated for taste. However, in the Osaka market, as for the 3 local brands of rice such as Koshihikari varieties produced in Shiga prefecture, Tottori prefecture and Kagawa prefecture, their taste evaluations are low but their prices are still high. This shows that the variety name of Koshihikari has brand power.

As for the local brands of rice other than the above mentioned, Hatsushimo variety produced in Gifu prefecture and Kinuhikari variety produced in Shiga prefecture, there are positive correlations between taste evaluation and price level.

In summary, among local brands, it has been estimated that Koshihikari varieties produced in Uonuma and Niigata town show prominent singularity. As for rice varieties, it has been estimated that Koshihikari variety has brand power.

Results of Hedonic Regression approach and their investigation

All local brands of rice in both the Tokyo market and the Osaka market are used for estimation. Estimation period is from the first trade of rice produced in 1990 to the third trade of the rice produced in 1996. During this period rice market trades have been carried out 30 times..

As a functional form, a semi-log model has been selected because Akaike's criterion test has shown it gives the best results among the linear model, semi log-model, double-log model and Box-Cox conversion type model. The estimation model is as following,

$$\text{Log } Yi = a + ß1\ X1 + ß2\ X2 + ß3\ X3 + ... + ß19\ X19 + ß20\ X20 + ß21\ X21$$

The results of the Hedonic Regression approach are shown in Table 3 and Table 4. As for rice quality, the 3 elements of appearance, flavour and stickiness have more effects on price gaps. As for characteristics in the crop cultivation, elements such as strength of stems, resistance against falling, tolerance for cold weather and disease resistance have effects on price gaps. As for the advantage in marketing, suitability for blending of paddy brands and the timing of shipment have affects on price gaps.

As for brand power by variety name, Koshihikari variety has big impacts on price gaps. As for brand power by local brand names, Koshihikari varieties produced in Uonuma town and Niigata town have big effects on price differences. Among these, Koshihikari variety produced in Uonuma town has 3 times stronger brand power than Koshihikari variety produced in Niigata town. Table 5 shows these factors affecting price gaps among local brands of rice.

Results on the price gaps among local brands of rice

The following points have been clarified,

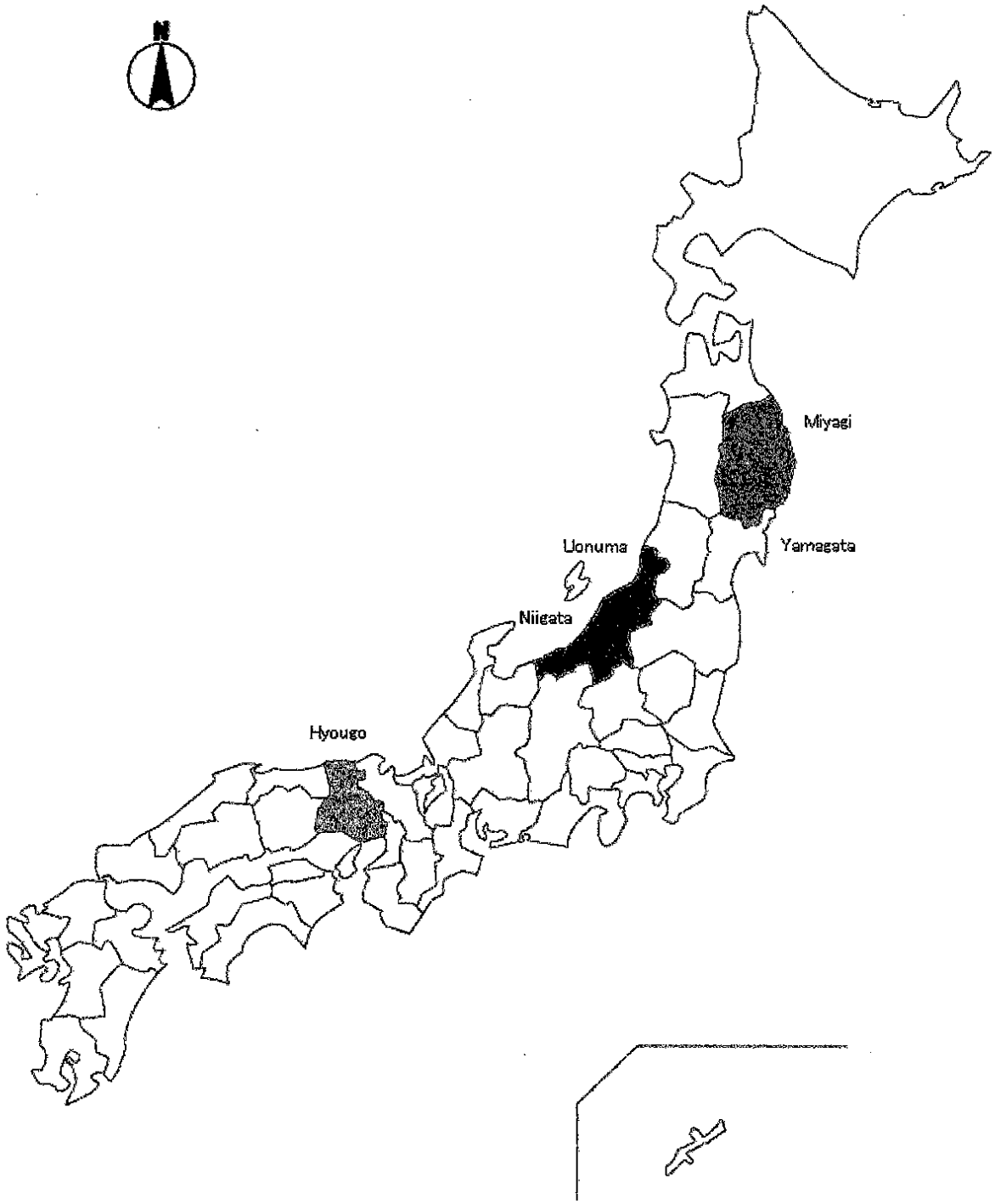
i) For the Tokyo market,

a) As for taste elements, the 4 items of appearance, flavour, stickiness and softness impact on price differences among the local brands. The relative ratio of strength of each factor is about 3:4:5:2.
b) As for crop cultivation characteristics, strength of stem, resistance against falling, tolerance for cold weather and disease resistance have effects on price gaps among the local rice brands. The relative ratio of strength of each of these factors is about 5:9:2:5.

ii) For the Osaka market,

a) As for taste elements, the 4 items of appearance, smell, flavour and stickiness affect on price gaps among the local brands. The ratio of the relative strength of each factors is about 7:2:8:8.
b) As for crop cultivation characteristics, weakness & strength of stem, resistance against falling, tolerance for cold weather and disease resistance have effects on price gaps among the local brands of rice. The ratio of the relative strength of each factors is

Figure 8 : Major Brand Rice Producing Areas



Relations among rice quality, yields and prices

According to the recent research report by Gemma (3), the following has been shown. For most people in Japan, rice is still a staple food. Rice still supplies the average Japanese with almost one third of their daily required caloric intake. However, a gradual decline in per capita rice consumption has been observed after reaching its peak in 1962. In 1994, 66.3 kg was consumed annually, about half the level of 1962 (Ministry of Agriculture, Forestry and Fisheries (MAFF),1996:1).

Over the years, household consumers have become more conscious about the quality of rice. They consider taste as

the most important factor when they make a purchasing decision. A survey carried out in 1995 found that 20 percent of the people asked indicated that taste matters more than price (Food Agency, 1996, p.210). Only two percent of the interviewed consumers thought price to be the most important factor when they buy rice. A majority (60 percent) of those surveyed thought that taste is as important as price in their selection of rice for purchase.

The consumers' willingness to pay for higher quality rice is observed in price relations at the market place. In the Tokyo wholesale market, a premium rice known for its good taste, Uonuma Koshihikari is being sold for prices over 100 percent higher than standard quality rice. A 10 kg package of Uonuma rice is sold for more than \7,000, while a package of standard quality rice of the same weight in sold for \3,500.

Rice is still being produced in Japan as a major agricultural product. It accounted for 34.2 percent of the total agricultural production in value in 1995, the largest share among different crops and animal products. What will happen to the dominance of rice in agricultural production in Japan? Although the liberalisation of the rice market will certainly result in a reduction in domestic production through lower output prices in the long-run, the dominance of rice cultivation in rural areas will not be changed so soon. The rural agricultural infrastructure has been improved over time for rice cultivation. Public and private assets related with rice cultivation have been accumulated. Marketing and processing channels for rice have also been in existence for a long time. Structural changes in production and marketing systems will require new investment and time to accommodate for a shift from rice production.

Although changes will occur to adjust the rice economy to the new economic environment by pulling out resources which may be better utilised elsewhere, efforts to make this sector more competitive will take place at the same time. Already attempts to amplify value added and to improve production and marketing efficiency have been undertaken. For rice breeders in Japan, developing higher quality, tastier rice varieties has been a major objective of their activities in recent years. This is to better serve the consumers whose preferences have been shifting towards tastier rice. Rice producers have benefited from the efforts with the price premiums.

The purpose of this paper is to study issues related to rice quality, yields and prices and to derive policy implications for the future of the Japanese rice economy. How the recent trend of dominance of Koshihikari as a produced rice variety may have impacts on the stability in rice yields is examined. How quality makes difference in rice prices is also investigated. Determinants of rice yields and area harvested are identified too. The answers to these questions will be useful when future policies are considered. Statistical tools are employed for these analyses.

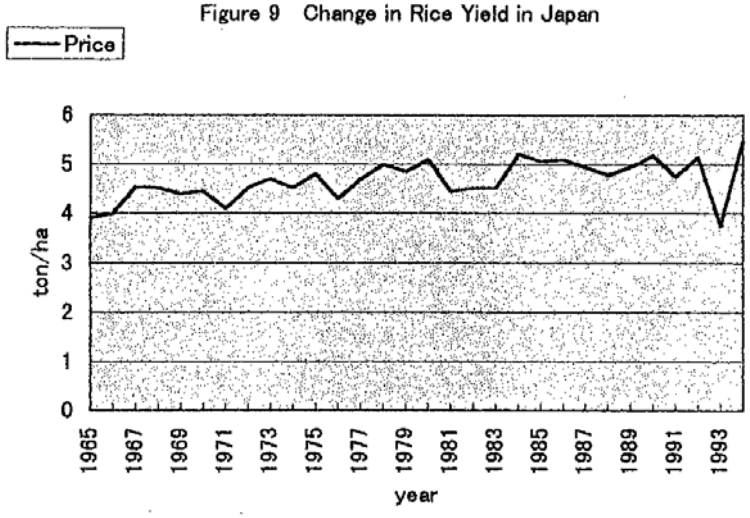
Recent Trend of Rice Yields

The growth in rice production has mainly come from the increase in yields in Japan. The country has been endowed with a limited supply of arable land. At the same time, population pressure is high. As Hayami and Ruttan (1985) argue, technological development in agriculture took place in the direction of overcoming the constraint on land. Yields increased as a result of the development of biological and chemical technology along with the improvement in irrigation systems at the beginning of the development stage. Acreage increase took place in a marginal way. Some forest and mountainous areas were converted into paddy fields. As economic development has progressed, labour has become relatively scarce and the rapid development of mechanical technology has taken place. This has also contributed to the increase in rice yields.

Figure 1 depicts the changes in rice yields in Japan. The yields have been gradually increasing, but have experienced volatility on the movement along the growth path. Not much growth has been observed since the middle of the 1980s. A decline in the relative price of rice, a setback in research and development investment in rice and an increasing emphasis on the production of 'brand' rice varieties which give a lower yield, are believed to be the contributing factors in this recent trend of stagnating Japanese rice yields.

Figure 9 : Change in Rice Yield in Japan

Figure 9 Change in Rice Yield in Japan



In response to the decline in demand for rice in the national economy and the increase in rice imports, the domestic supply has to make a necessary adjustment in Japan. Acreage for rice cultivation has been reduced using land conversion and set aside programs. Economic incentives have been utilised for encouraging participation to the programs. Even punitive measures have been indirectly employed to achieve the targeted acreage reductions. Priorities in subsidies for rural development have been lowered for the areas which have not met the government imposed goals.

Seeking outside employment opportunities and finding more profitable crops to grow have been critical considerations for the survival of farm operators. Enlargement of value added in rice cultivation has also been considered as a worthwhile effort. Choosing 'brand' rice for production is along this line to improve farm income in Japan. This has some drawbacks. First, the production risk may be increased. Tastier rice variety may be more vulnerable to climatic condition changes. Yields drop may be larger in a bad crop year. Second, average rice yields may be reduced. The predicted profit increases from tastier rice, taking into account price premiums and changes in costs, should be greater than that derived from producing a higher yielding standard quality rice variety.

Relations among rice quality, yields and price

In 1993, the Japanese rice production sector was hit by a cold summer and the rice yield dropped to 75 percent of the level of a normal year. The severity of the damage was partly blamed on the concentration of production on a limited number of premium rice varieties. Rice blast disease also spread during the cold weather. Koshihikari is not strongly resistant to this disease. A hypothesis testing is carried out here to see whether the deep decline in rice yields is related to mono-cultivation of premium rice varieties. Another test is also undertaken to see if premium rice is evaluated highly by consumers. The relationship between rice prices and quality(taste of rice) is examined. Then rice yields and acreage equation are estimated. These results form the basis for policy recommendations.

First, a yield index is regressed on an index of rice variety concentration using 1993 data from 46 prefectures(all prefectures except Okinawa where the information was not available). The yield data are from the Food Agency (1995) and the rice variety data are taken from the MAFF (1996:2).

```
YI=84.49***-0.37**CON+22.84***DKT+26.58***DH+21.82***DKS
(11.59) (-2.45) (3.75) (3.27) (3.65)

+13.07*DSI+16.60**DSK          (1)
(1.92) (2.21)

adjusted R2=0.35 D.F.=39
```

*** 1 percent significance level, ** 5 percent significance level and * 10 percent significance level,
The number in parentheses are t-value.
YI: Yield Index (ratios of actual rice yields to the normal yields announced by the Food Agency (in percentages)); CON: Concentration (calculated as the share of the rice variety with the largest proportion in the total planting areas); DKT: Dummy variable for Kanto; DH: Dummy variable for Hokuriku; DKS: Dummy variable for Kansai; DSI: Dummy variable for Sanin and DSK: Dummy variable for Shikoku.

Rice yields were found to be negatively correlated with the rate of concentration of premium varieties. The estimated coefficient of CON is a statistically significant negative. Prefectures with higher concentrations experienced a sharper decline in rice yields, observable from the 1993 data when the summer was particularly cold. This statistically proves an existence of a production risk related to the concentration of rice varieties in planting.

Next, factors influencing market prices are examined. Rice quality is found to be an explanatory factor here. Although rice quality is conventionally differentiated by producers with physical characteristics such as the rate of broken rice and water content, consumers tend to use a different set of quality characteristics to distinguish one rice variety from another. The latter list includes flavour, appearance, easiness to cook and healthiness (Ohtsubo, p.33).

The government inspections conducted by the Food Agency of rice quality are performed for both government distributed rice and voluntarily distributed rice through the examination of physical characteristics of sampled rice. Another type of quality examination is carried out by Nihon Kokumotsu Kentei Kyokai (Japan Grain Inspection Association). The Association's review is based on the investigation of appearance, smell, flavour, stickiness and softness of rice. Tasters scrutinize cooked white rice of major rice varieties from each prefecture every year.

How the rice prices are related with rice quality is examined next using the cross section data of rice price and quality. For rice prices, the average auctioned prices of voluntary rice in the wholesale markets in 1994 and 1995 are used (Food Agency, 1995 and 1996). For rice quality figures, data from Nihon Kokumotsu Kentei Kyokai (1996) which ranked rice quality in five grades are employed. Regression analyses produced the following equations.

```
PR94=16969.15***+834.48***T94+1248.53***DK1+1114.42***DS
(35.6) (6.46) (5.54) (2.99)

+2598.73***DN                  (2)
(7.69)

adjusted R2=0.69 D.F.=61

PR95=16046.18***+821.35***T95+1571.65***DK2+2802.19***DN
(24.22) (4.55) (5.20) (5.82)     (3)

adjusted R2=0.64 D.F.=62
```

PR94 & PR95: Average auctioned prices for voluntary rice at the wholesale markets (yen/60kg); T94 & T95: JAGI rice quality index (1 to 5 range, 5 shows the best quality); DK1: Dummy variable for Koshihikari; DK2: Dummy variable for Koshihikari and its relative varieties (up to 50 percent genetic linkages); DS: Dummy variable for Sasanishiki and DN: Dummy variable for Niigata.

Price variations among different rice varieties from separate prefectures were accounted for in equations 2 and 3. Quality differences from the view of consumers were found to be an important explanatory factor here. The rice varieties with brand power such as Koshihikari and Sasanishiki were found to command price premiums. The inclusion of Twenty-eight prefecture dummy variables in the model was attempted. However, only the Niigata Prefecture dummy became statistically significant. This shows that wholesale rice prices are mostly formed based on the rice varieties rather than the location of production. Rice produced in Niigata is an exception and its rice gets a price premium in the market regardless of the variety.

```
PR94=15792.79***+946.84***T94+23.16***K3+1872.95***DN
(24.71) (5.42) (5.61) (4.57)

+729.61***DHK               (4)
(2.40)

adjusted R2=0.82 D.F.=33

PR95=14395.66***+951.10***T95+25.78***K3+3217.78***DN   (5)
(11.92) (2.87) (3.19) (4.64)

adjusted R2=0.63 D.F.=34
```

DHK: Dummy variable for Hokuriku and K3: Variable showing the genetic closeness to Koshihikari (in percentage) (Azuma (1996,Table 3-2, p.70-71) was used).

These two equations show that having genetic closeness to Koshihikari helps in acquiring a premium price. The closer the genetic relationship, the higher the market prices we observe here. By the similarities in taste characterized by low amylose and protein contents, the Koshihikari family must have been preferred by consumers (Yokoo, 1996).

```
YD94=558.40***-31.15**DK2+54.41***DTK-44.06*DS    (6)
(50.46) (-2.52) (4.14) (-1.89)

adjusted R2=0.32 D.F.=45

AC95=-137835.24***+6.76***PR93+74523.11***DHO
(-2.70) (2.99) (5.92)

+17352.07***DTK+25685.22**DN      (7)
(2.82) (2.06)

adjusted R2=0.50 D.F.=43
```

YD94: Yields; DTK: Dummy variable for Tohoku; DHO: Dummy variable for Hokkaido; DS: Dummy variable for Shikoku; AC94: Acreage; DH: Dummy variable for Hokkaido and DKT: Dummy variable for Kanto.

Equation 6 represents the relationship between Koshihikari varieties and rice yields. These were found to be negatively correlated. This cross-section data analysis supports the hypothesis that a nation-wide trend of growing this particular brand name rice variety is a factor for the slow rate of increase in Japanese rice yields for recent years. This is certainly a disadvantage of producing a rice variety with a premium price. A low value of adjusted R2 indicates that there are other factors which are not accounted for here to explain the rice yields.

In equation 7, dummy variables were used to explain the regional differences in initial land endowments. The estimated parameter on PR93 is statistically significant and positive. The farmers' supply responsiveness to price differences has been shown here. This is the reason for the popularity of the production of premium rice varieties such as Koshihikari and Sasanishiki.

Conclusions and policy implications

The following points have been shown from the Cluster analysis and Hedonic Price Regression Analysis in the preceding section. For both the Tokyo and Osaka markets,

- a) Price differences among the local brands of rice are affected by the differences in both quality factors and non-quality factors.
- b) As for rice quality factors, crop cultivation characteristics as well as taste have impacts on price gaps.
- c) As for taste elements, the 3 items of appearance, flavour and stickiness have significant effects on price gaps among local brands of rice.
- d) Koshihikari varieties produced in Uonuma town and Niigata town have great brand power. Especially the former (Uonuma brand) has 3 times greater brand power than the latter (Niigata brand). Also the name of Koshihikari variety itself has strong brand power.

Why certain rice varieties have dominated the Japanese markets has become clear in this paper. First, consumers' willingness to pay higher prices for tastier rice varieties has been proven. A positive correlation between rice quality (in terms of taste) and prices was confirmed in the data analysis. Koshihikari and Sasanishiki were verified to be the rice varieties which receive the highest prices. Even the varieties which are genetically related to Koshihikari were revealed to command higher prices. The closer a variety's relation to Koshihikari, the higher the price it is able to command. Variety was also detected to matter more than location of production with an exception for rice grown in Niigata. Second, the rice producers' incentive for growing Koshihikari has been verified. Supply responsiveness to premium prices was the cause of allocating more land for rice cultivation.

Considering the confirmed production risk of growing a limited number of rice varieties, the diversification of rice varieties grown in Japan is desirable. The concentration of varieties not only increases the potential risk for a major crop failure, but also limits improvements in the efficiency of labour and farm machinery use. Farmers in a same area now tend to replant and harvest almost at the same time because they produce the same rice variety. Harvesting equipment is utilized only for several days a year. Sharing a piece of machinery to reduce production cost is difficult under the current conditions because everyone wants to use it in the same particular period. Progress in breeding efforts to develop Koshihikari varieties with different growing periods would help resolve this problem. This should be added to the research agenda of the rice breeders who are already making efforts to increase disease and stress tolerance as well as to further improve taste.

So far independent efforts have been made in each prefecture to cope with these issues and promote prefecture-specific brand rice varieties. The rice varieties that are promoted in a prefecture typically receive a final screening in a prefectural experimental station. Then, the information is sent to rice farmers through extension networks organized by the prefecture and local farmer cooperatives. The above economic study found that market prices have been based, not on where the rice is produced with the exception of Niigata, but on what rice variety it is and how tasty the rice is. Research and extension efforts can be combined among neighboring prefectures that share similar climatic and soil conditions. This would save public money and time, both of which are currently scarce.

As shown in the beginning section of this paper, the new system of rice distribution under the New Food Law has tried to expand the share of voluntarily distributed rice channel under the certain government regulation. Premium prices tend to be given for the high quality variety and preferred brands of rice. Producers try to carry out value added in their rice in terms of the cultivation method, drying method and storage method, such as organically grown rice, chemical and pesticide free products. However, the new distribution system has faced several restrictions and its free price formation function has not always been realized so far. The consumers' consciousness for food safety has increased under the gradually increasing situation of the minimum access import. . So the labeling system which guaranteed the organically grown products has to be improved in both international and national scale.

References

(1) Azuma, Masaaki, "Brand Hinshu Kaihatsu no Genjo to Tenbo" (Current Situations and Prospects for the Development of Brand Rice Varieties), Chapter 3, 21 Seiki ni Muketa Oishii Kome no Kaihatsu Senryaku, Nourin Suisan Gijutsu Joho Kyokai, 1996
(2) Food Agency, Beikoku Data Book (Rice-wheat Data Book), Mizuho Kyoukai,1995 and 1996
(3) Gemma Masahiko, "Rice Quality, Yield and Prices in Japan", in Projection and Policy Implications of Supply and Demand of Rice in South Korea, Taiwan, Japan and USA, kobe Univ. March 1997
(4) Hayami, Yujiro and Vernon Ruttan, Agricultural Development, Johns Hopkins University Press, 1985
(5) Kawaguchi Nobohiro, "Assessment on Price Differences of Local Brands of Rice", mimeo, Feb. 1997
(6) Ministry of Agriculture, Forestry and Fisheries:(1), Shokuryo Jukyu Hyo (Food Balance Sheet), 1996
(7) Ministry of Agriculture, Forestry and Fisheries:(2), Sakumotsu Tokei (Crop Statistics), 1996
(8) Nihon Kokumotsu Kentei Kyokai, Heisei 7 Nensan Kome Shokumi Ranking, 1996
(9) Ohtsubo, Kenichi, "Kome no Oishisa o Hakaru" (Measuring Tastefulness of Rice), Chapter 2, Kome no Oishisa no Kagaku, Nourin Suisan Gijutsu Joho Kyokai, 1996
(10) Yokoo, Masao, "Sekai no Kome no Hinshitsu Tokusei" (World Rice Quality Characteristics), Chapter 2, Sekai no Kome to Nihon no Kome, Nourin Suisan Gijutsu Joho Kyokai,1996.

Figures and tables summary

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Home

EU Concerted Action for "Quality and Competitiveness of European Rices", EC-DG VI, AIR3-PL93-2518