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Implications of the minimum access rice import on supply and demand balance of rice in Japan

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Abstract

The recent development of rice policies in Japan are summarized. The impact of the minimum access (MA) import on the supply and demand balance of rice, and the rice diversion areas in the future is also predicted. © 1997 Elsevier Science B.V.

1. Emerging issues in the Japanese rice sector

The Japanese rice industry has been changing drastically recently. The biggest change is the partial opening of the rice market in 1995. As a result of the acceptance of the GATT Uruguay Round accord, Japan is required to become a regular rice importer. The current GATT accord allows Japan to exempt rice from tariff imposition for the period 1995–2000. In return for this concession, Japan started the minimum access rice import in April 1995, with 4% of domestic rice consumption, gradually increasing to 8% by 2000. The GATT accord requires additional and acceptable concessions in return for an extension of this grace period after 2000. Another multilateral negotiation will be held in 2000 and the Japanese government has to decide whether to accept the tariff measure or to extend the minimum access (MA) scheme. This partial opening of the rice market will have a big impact on the domestic rice industry, and requires reexamination of the current food control system.

Besides the MA rice import, the Japanese rice sector faces the following emerging issues. First, domestic rice production costs are far higher than the international prices due to small-scale farming, relatively high labor costs, high land costs, and overinvestment in farm machinery. A rapid increase in the exchange rate of the yen in recent years has further increased domestic rice prices compared to border prices. Since Japan has partially opened the rice market, it will be critically important to reduce the difference between domestic production costs and that of the major rice exporting countries. The government has implemented various measures to reduce production costs by promoting structural improvement policies and accelerating technological change. However, the size structure of Japan's rice farms has remained relatively static. Although the number of large-scale rice farms has increased slightly, the average rice harvested areas per rice farm household were 0.57 ha in 1975, and have not increased significantly since then. The cost of rice

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production in Japan still far exceeds that of rice-exporting countries.

Second, rice is an inferior commodity in Japan, and the ongoing decline in rice consumption will continue in the future. On the other hand, the supply of rice will increase as a result of the MA rice import and rice yield increase. Therefore, the rice diversion program will have to be strengthened in the future to maintain a balance between supply and demand. Under the Food Control Law, the rice diversion program required all rice producers to divert the same proportion of their paddy field from rice production regardless of their farm size. Thus, the rice diversion program discouraged full-time and core farmers from trying to expand their scale of operations. Many researchers pointed out the importance of improving the current rice diversion program so that it does not prevent the fostering of efficient large-scale rice farms.

Third, the average age of rice farmers has been increasing because of the decline in the number of young newcomers into rice farming. This is due to the inferior income available from rice farming and less favorable working conditions compared with nonagricultural economic activities. Most rice is produced by small scale part-time farm households with a high dependence on off-farm income, and their production efficiency is relatively low compared with large-scale full-time farm households. About 86% of rice growers are part-time farmers, and they also harvest about 86% of the rice areas.

Lastly, the original calorie self-sufficiency rate has been falling continuously, from 73% in 1965 to 46% in 1995. This is the lowest level among the major developed countries. The self-sufficiency rate for food grain was 80% in 1965 and continued to decline, falling to 62% in 1994; this trend is expected to continue further due to the MA rice import. Although food security and high self-sufficiency are not necessarily the same thing, it is important to maintain a certain level of food self-sufficiency for a country with a large population like Japan.

Thus, the Japanese rice sector is confronting very serious problems, and the Japanese government has implemented various measures to cope with these problems. The objectives of this article are to summarize the recent development of rice policies in Japan, and to predict the impact of the MA import on the supply and demand balance of rice and the rice diversion areas in the future.

2. Recent changes in rice policy

A series of agricultural policy reform have been taking place to adapt the Japanese agricultural and rice sector to radically changing socioeconomic environments since the early 1990s. In June 1992, the Ministry of Agriculture, Forestry, and Fisheries (MAFF) introduced a new agricultural policy entitled 'The Basic Direction of New Policies for Food, Agriculture and Rural Areas'. This policy aims to adapt Japanese agriculture to an open trade system. This new policy points out that the existing regulations and protection at the production and distribution stages should be reexamined, and relevant policies be changed in a manner that would further introduce market principles and competition (MAFF, 1992).

The 'Major Food Grain Supply and Demand Stabilization Law' (referred to as NFL) was passed by Congress in December 1994, and was implemented in November 1995. This law took the place of the Food Control Law that had played an important role in stabilizing rice prices, as well as the supply and demand of rice for more than 50 years. Major differences between the NFL and the Food Control Law are: (1) the government purchases rice from the producers who participate in the rice diversion program; (2) the government builds buffer stocks based on purchases of domestic- and foreign-produced rice; (3) rice prices should reflect the current market supply/demand situation, and government intervention should be minimal. With the introduction of the NFL, the government shifted from the total control to partial control of rice, and the role of the government has been limited to price stabilization by means of buffer stock operations.

Historical changes in the rice diversion policy, rice distribution policy, and structural improvement policy can be summarized as follows.

2.1. Rice diversion policy

The rice production expanded rapidly in the 1960s due to increase in government procurement prices and technological changes such as the development of high-yield varieties and improved cultivation methods. Rice production started to exceed domestic rice consumption at the end of the 1960s, resulting in an accumulation of surplus rice in government storage. The storage cost and the disposal program of accumulated old rice put pressure on the expenditure of the Food Control Special Account, greatly increasing its deficit. To prevent the accumulation of surplus rice, a series of rice diversion programs have been implemented since 1969. Rice production has been adjusted to the declining domestic rice consumption through the rice diversion program for more than 35 years.

The government established an overall plan for rice each year, and the rice diversion program was included in this plan. The Minister of MAFF decided the nationwide goals for rice diversion acreage, and allocated the national rice diversion acreage to individual prefectures based on several criteria. The governor of each prefecture then reallocated the acreage to the individual cities and towns. Finally, the goal was divided among the rice producers at hamlet level for the sake of fairness (Wailes et al., 1991). The rice acreage reduction quota was distributed by administrative guidance, not by law, but farmers did not consider it voluntary. Rice growers were compelled to fulfill rice acreage reduction quotas by both the national government authorities and by the agricultural cooperatives. As a measure to promote the rice diversion program, crop diversion subsidies were paid to farmers. The achievement rate of the diversion target was high, in most years over 100%. There was practically no flexibility for rice producers in determining the areas planted with rice. Large-scale rice growers, as well as small-scale rice growers had to divert the same proportions of their paddy fields from rice production. When rice farmers expanded their paddy farm size, they had to divert larger areas of their paddy fields from rice production. Since there were very few good alternative crops that could give a comparable income, it was not attractive for farmers to expand paddy farm size, thus impeding the materialization of economies of scale in rice production.

With the introduction of the NFL, the government implemented a rice diversion program in cooperation with the agricultural cooperatives in 1996. The government still establishes an overall plan for rice each year and continues to implement a rice diversion program. The government purchases rice only from the participants, although the producers can choose whether to participate in the rice diversion program or not. The government, which feels strongly responsible for the stabilization of the domestic rice market, actively solicits rice producers for participation in the program so that it will be able to forecast rice supply more precisely. To facilitate the achievement of the diversion target, the government pays diversion subsidies to participants in the program. The agricultural cooperatives implemented a nationwide system known as the mutual compensation program (Tomo Hosho in Japanese), in which farmers, who do not divert their allocated paddy fields from rice production, provide financial assistance to those who divert more paddy fields from rice production than is allocated to them. The government also pays a subsidy to participants in the mutual compensation program. Thus, farmers can adjust rice diversion acreage among themselves through the mutual compensation scheme.

2.2. Rice distribution

Under the Food Control Law, rice was distributed through government marketing channels until the end of the 1960s. Only agents designated by the Food Agency could participate in rice marketing, and rice prices were regulated by the government. As rice supply increased and achieved self-sufficiency, these regulations were gradually relaxed. Beginning in 1969, rice was classified into two categories, direct-government-controlled rice and indirect-government-controlled rice. The indirect-government-controlled rice, which is called 'voluntary rice' (Jishu Ryutsu Mai in Japanese), was established due to the pressure of an enormous government budget deficit created by large rice purchases and the disposal of old rice at discounted prices. The voluntary rice category was designed to introduce a free market channel for high-quality rice. To increase the share of voluntary rice, the government paid subsidies to rice producers for rice sold through the voluntary rice channel (Hayami, 1988). The majority of rice was direct-government-controlled rice in the 1970s, but as income increased, consumer demand for high quality rice gradually increased. The proportion of voluntary rice increased steadily from approximately 40% in 1988 to 70% in 1994.

Since 1990, the market price of voluntary rice has been determined at the auction sponsored by the Price Finding Organization for Voluntary Rice, which is a subsidiary organization of the Food Agency of Japan. A limit used to be imposed to control the volatility of rice prices determined at the auction. Fluctuation of prices up to $\pm 7\%$ only, during each marketing year, was permitted (Yamaji and Ito, 1993). With the introduction of the NFL the Price Finding Center for Voluntary Rice was introduced in the place of the Price Finding Organization for Voluntary Rice. The price of voluntary rice was 40–50% above the government procurement price. If rice supply increases due to more production outside the rice diversion program, the market price may fall, putting a downward pressure on the government procurement price in the future. Government rice procurement, which accounted for only about 15% of total rice production, is manipulated to build a buffer stock. Currently, the Food Agency of Japan considers that an appropriate level of buffer stock should be as much as 1.5 million metric tons (mmt).

2.3. Structural improvement policy

Since the introduction of the Agricultural Basic Law of 1961, MAFF has implemented structural improvement policies. However, structural improvement policies were not successful in improving the farm size structure due to the rapid increase in farm land prices and the farmers' determination to hold on to farmland as an important asset of their farm households. The average farm size increased only by 0.31 ha over the 23 years, from 1.07 ha in 1970 to 1.39 ha in 1993.

The need to adapt Japanese agriculture to an open trade system has been increasing recently. To help achieve this, MAFF has introduced the Basic Direction of New Policies for Food, Agriculture and Rural Areas, in which the outlook for the agricultural structure, with rice farming at its core, 10 years from now is described as follows: 150 000 individual farm management bodies with 10–20 ha of farm size and 20 000 organized farm management bodies with 35–50 ha of farm size will produce about 80% of total rice production. Their average rice production cost is expected to be about 50–60% of that of the average rice growers at present. MAFF has been implementing measures to foster large-scale rice producers who are enthusiastic about rice farming. Those measures aim, first, to promote the aggregation of farmland in the hands of those farmers who endeavor to conduct farm management in an efficient and stable manner, and second, to promote farm work on a commissioned or entrusted basis that can eventually be linked to scale expansion and the aggregation of farmland (MAFF, 1992).

3. Rice demand analysis

3.1. Estimation of rice demand function

As a first step on the quantitative analysis of the impact of the MA import on the supply and demand balance of rice and the rice diversion areas, rice demand will be projected using a partial equilibrium model. It is assumed that the representative consumer maximizes utility, given a fixed income. The demand schedule for rice is derived by maximizing the consumer's utility, and per capita demand for rice is a function of income, rice price and prices of substitutes of rice. The rice demand function to be estimated is as follows:

$$\ln C_t = a_0 + a_1 \ln Y_t + a_2 \ln P_{rt} + a_3 \ln P_{mt} + a_4 D_t + e_t \qquad (1)$$

where C is annual per capita rice demand, Y is per capita private final consumption expenditure, P_r is rice price, P_m is meat price, D is dummy variable, and e is disturbance term. Expenditure and prices are deflated by the consumer price index of the 1985 base year.

The Japanese economy has grown at around 10% in real terms since the end of the 1950s, but the economic growth rate has slowed down since the First Oil Crisis of 1973. Per capita real expenditure on food has been increasing at high rates in the 1960s and the early 1970s, but has leveled off since 1973. Annual per capita calorie supply has also shown similar trends. A dummy variable is introduced in Eq. (1) to capture the effect of these

Table 1
Assumptions on annual rate of change of variables (%)

Variables	Case 1		Case 2
	Annual rate of change	Estimation period	Annual rate of change
Per capita real private final consumption expenditure	3.0	1970–1991	2.0
Real consumer rice price	−0.3	1986–1991	−1.5
Real consumer meat price	−1.7	1976–1991	−1.7

socioeconomic changes on rice demand. D takes 1 for 1970–1973, and 0 for 1974–1991. The coefficient of the dummy variable is expected to take a positive sign.

The rice demand function is estimated using the time series data of the period 1970–1991 by OLS and the estimation result is as follows [1]:

$$\ln C_t = \underset{(13.874)}{5.961} - \underset{(-11.526)}{0.308} \ln Y_t - \underset{(-3.836)}{0.130} \ln P_{rt} + \underset{(7.013)}{0.264} \ln P_{mt} + \underset{(5.180)}{0.034} D \quad (2)$$

$$\bar{R}^2 = 0.995 \qquad \text{D.W.} = 1.288$$

The coefficient of determination adjusted for degrees of freedom is 0.995, and all parameter estimates are different from zero at the 5% significance level. The demand for rice is negatively related to income and own price, and is positively related to meat price as expected. This implies that rice is an inferior commodity and meat is a substitute for rice. The own price elasticity is −0.130 and the expenditure elasticity is −0.308 [2]. The sign of the coefficient of the dummy variable is positive as we expected. This implies that socioeconomic changes that took place around 1973 had negative effect on rice demand.

3.2. Projections of rice demand

The future per capita rice demand is projected based on the estimated parameters and assumptions on the future values of the explanatory variables of the rice demand function. Two cases are assumed with respect to future values of the explanatory variables. As shown in Table 1, case 1 assumes that past trends of these explanatory variables will continue in the future. The average annual rate of changes of these variables are estimated by regressing these economic variables to time. Table 1 shows the estimated results of the annual rate of change of these economic variables.

We also introduced another set of assumptions that correspond to a lower growth rate of per capita consumption expenditure, and a higher rate of decline in rice prices than in case 1 as shown in Table 1. The Japanese economy has experienced a rapid expansionary phase in the late 1980s and reached a peak in 1991. However, the economic growth rate has slowed down since then, and future economic growth rate seems to be lower than the period 1970–1991, the period we estimated the growth rate of per capita private final consumption expenditure [3]. Therefore, the growth rate of per capita private final consumption expenditure in the projection period will be lower than the past trend. Thus, we introduced a 2% growth rate of per capita private final consumption expenditure as our case 2 assumption. Consumer rice price seems to decline at faster rates

[1] The data for the annual per capita rice demand, rice price, and meat price are collected from 'Annual Report on the Family Income and Expenditure Survey', Statistics Bureau, Prime Minister's Office. The data for private final consumption expenditure is obtained from 'Annual Report on National Accounts', Economic Planning Agency, Government of Japan. The consumer price index is obtained from 'Annual Report on the Consumer Price Index', Statistics Bureau, Management and Coordination Agency, Government of Japan. The collected data are all annual data of the period 1970–1991.

[2] Several studies have estimated price elasticity and income elasticity of rice. The estimate of price elasticity by Zhang (1990) is the same as our estimation result, i.e., −0.13. The estimation result of price elasticity by Yoshida (1990) is −0.16 and is similar to our estimation result. Yoshida estimated an income elasticity of −0.34, which is close to our estimation result of −0.308. Zhang estimated the income effect to be −0.14.

[3] Real GNP growth rate was 1.1%, −0.2%, 0.5% for 1992, 1993, 1994, respectively.

Table 2
Projections of rice demand (milled rice)

Year	Per capita rice demand (kg)		Total rice demand for direct food use (1000 t)		Total rice use (1000 t)	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
1994	68	69	8552	8583	9078	9078
1995	68	68	8465	8531	9297	9365
1996	67	67	8380	8480	9209	9311
1997	66	67	8297	8429	9123	9258
1998	65	66	8215	8392	9037	9219
1999	64	66	8135	8342	8955	9167
2000	63	65	8056	8293	8873	9114
2001	62	65	7979	8256	8793	9076
2002	62	64	7902	8206	8713	9023
2003	61	64	7825	8167	8633	8983
2004	60	63	7747	8127	8554	8940
2005	59	62	7668	8071	8471	8882
2006	59	62	7582	8020	8382	8828
2007	58	61	7497	7968	8294	8773
2008	57	61	7413	7903	8207	8706
2009	56	60	7330	7850	8120	8651
2010	56	60	7247	7798	8034	8596

due to the acceptance of the GATT Uruguay Round agreement, which requires agricultural protection measured in AMS to be reduced, and the government expenditure on price policies will be cut back. Therefore, consumer rice price is assumed to decline annually at 1.5% in case 2.

Projection results of rice demand based on the case 1 assumption are considered as our baseline projections. We consider the projection results based on the case 2 assumption to be more likely to occur, since the growth rate of the Japanese economy in the future seems to be lower than in the past, and the declining rate of rice price seems to accelerate in the future, due to the cutback of the budget for rice protection policy.

Table 2 shows the projection results of rice demand for these two cases. Rice demand declines much faster in the case 1 projection than in the case

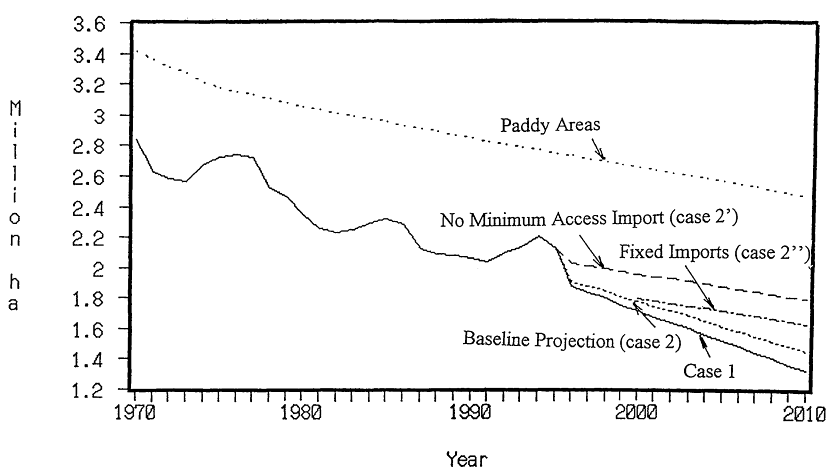

Fig. 1. Projections of paddy field areas and rice planted areas.

2 projection because of the assumption of higher growth rate of per capita consumption expenditure and lower rate of decline in consumer rice price. In the case 2 projection, per capita rice demand for direct food use is 69 kg in 1994, and is predicted to decline to 60 kg by 2010 [4]. On the average, per capita rice consumption is projected to decline by 0.6 kg per annum, and the rate of decline is about a half of that of the period 1970–1991.

Total rice demand for direct food use in the future is calculated as the product of the projected per capita rice demand and the projected population [5]. In the case 2 projection, total rice demand for direct food use is predicted to decline by 49 000 metric tons per annum on the average over the projection period. This annual decline is about 30% slower than that of the past two decades.

Total rice use is projected as a sum of total rice demand for direct food use, demand for processed food, seed, and loss. Annual rice demand for processed food during the period 1994–2010 is assumed to be equal to the annual average of the period 1983–1992; 583 000 metric tons. Rice demand for seed is forecasted as the product of the quantity of seed used per unit of rice area and the projected rice acreage. On the average, 33 kg of seed is used per 1 ha in the past years, and the same amount of seed is assumed to be used in the future. Loss of rice is calculated as 1.85% of total rice use, which is the average loss rate in the past years. The projection results of total rice use are shown in Table 2 and Fig. 1. In the case 2 projection, total rice use is predicted to increase from 9.078 mmt in 1994 to 9.365 mmt in 1995, and decline gradually to 8.596 mmt by 2010.

4. Rice supply analysis

4.1. Model development

Under the rice diversion program, the government has controlled total rice acreage by setting the target rice diversion areas each year. The government determines the rice diversion areas by subtracting the target rice areas from the projected paddy field areas. The target rice areas are the areas required to produce the amount of rice necessary to fulfill rice demand. For example, in 1991 the diversion target was 830 000 ha, which is the difference between the paddy field areas of 2.8 million ha and the target rice areas of 1.97 million ha. The target rice areas of 1.97 million ha are derived by dividing the sum of projected rice consumption and quantity needed to adjust for year-end stocks by the projected rice yield. In terms of rice quantity, 3.64 mmt were the target adjustment quantity, which is the difference between the potential rice production of 12.60 mmt and the total rice use of 8.96 mmt. Taking these procedures of the rice diversion program into consideration, future rice acreage and total rice production are projected as follows.

Total rice supply in year t is the sum of rice production in year $t-1$, ending rice stocks in year $t-1$, and rice imports in year t. While total rice demand in year t consists of total rice use, rice exports, and ending rice stocks in year t. These relations can be expressed in mathematical equations as follows:

$$S_t = Q_{t-1} + \mathrm{ST}_{t-1} + M_t \quad (3)$$

$$D_t = C_t + E_t + \mathrm{ST}_t \quad (4)$$

where S: total rice supply; Q: rice production; ST: ending rice stocks; M: rice imports; D: total rice demand; C: total rice use; E: rice exports.

Total rice supply is always equal to total rice demand in each year.

$$S_t = D_t \quad (5)$$

From Eqs. (3)–(5), we can derive Eq. (6).

$$Q_t = C_{t+1} + E_{t+1} - M_{t+1} + \mathrm{ST}_{t+1} - \mathrm{ST}_t \quad (6)$$

MAFF considers 1.365 mmt as the adequate rice stock level in the NFL. We also consider this to be the desired rice stocks in this study. It is assumed that there will be no rice export on commercial base because domestic rice prices far exceed the border prices. Then, Eq. (6) can be expressed as

$$Q_t^* = C_{t+1} - M_{t+1} + 1.365 - \mathrm{ST}_t \quad (7)$$

where, Q_t^* is the target rice production in year t. From a policy maker's point of view, rice production

[4] In this study all quantities for yield, production, consumption, trade, and stocks are on milled basis unless otherwise noted.

[5] The projection of future population is derived from 'Future Population Projections of Japan', Institute of Population Problems, Ministry of Health and Welfare.

Table 3
Projections of paddy areas, rice-planted areas, rice diversion areas, rice yields and rice production (milled rice)

Year	Paddy areas (1000)	Rice-planted areas (1000 ha)				Rice diversion areas (1000 ha)				Rice yields (kg/10 a)	Rice production (1000 t)			
		Case 1	Case 2	Case 2′	Case 2″	Case 1	Case 2	Case 2′	Case 2″		Case 1	Case 2	Case 2′	Case 2″
1995	2747	2118	2118	2118	2118	629	629	629	629	457	9730	9730	9730	9730
1996	2728	1872	1902	2019	2019	856	826	709	826	458	8583	8718	9258	8718
1997	2709	1829	1869	2003	2003	880	840	706	840	460	8419	8601	9219	8601
1998	2690	1791	1837	1988	1988	899	853	702	853	461	8260	8472	9167	8472
1999	2671	1750	1802	1969	1969	921	869	702	869	463	8102	8342	9114	8342
2000	2652	1713	1774	1957	1790	940	878	695	862	464	7944	8227	9076	8304
2001	2633	1672	1739	1938	1772	961	894	695	861	466	7786	8096	9023	8251
2002	2615	1635	1710	1925	1760	980	905	690	855	467	7629	7979	8983	8211
2003	2596	1595	1678	1909	1744	1001	918	687	852	468	7473	7860	8940	8168
2004	2578	1558	1646	1893	1728	1020	932	685	850	469	7313	7725	8882	8111
2005	2560	1517	1612	1874	1710	1043	948	686	850	471	7147	7593	8828	8056
2006	2542	1479	1580	1859	1695	1063	962	683	847	472	6982	7460	8773	8001
2007	2524	1439	1544	1837	1674	1085	980	687	850	474	6817	7316	8705	7934
2008	2506	1402	1513	1822	1660	1104	993	684	846	475	6654	7185	8651	7879
2009	2488	1362	1480	1804	1642	1126	1008	684	846	477	6491	7052	8596	7824
2010	2471	1326	1450	1789	1627	1145	1021	682	844	477	6331	6921	8542	7770

in year t should be equal to the sum of expected domestic rice use in year $t+1$, expected rice imports in year $t+1$, and the difference between the desired rice stocks and the ending stocks in year t. We assume rice imports are limited to the MA import that is already fixed for the period 1995–2000. Total rice use in year $t+1$ is already projected in the last section. Therefore, the target rice production in year t can be calculated by using Eq. (7) [6].

Once the target rice production level is projected, the target rice diversion areas can be calculated as the difference between the projected paddy field areas and the target rice areas, i.e.,

$$\mathrm{SA}_t^* = \mathrm{PF}_t - Q_t^* / {}_{q_t} \tag{8}$$

where SA*: target rice diversion areas; PF: projected paddy field areas; Q^*: target rice production; q: projected rice yields.

Empirical study is carried out using this model as follows. First, future rice yields and paddy field areas are projected by using time series data. Second, future target rice diversion areas are calculated by substituting projected values of paddy field areas and rice yields in Eq. (8). Projected paddy field areas are considered as the potential rice planting areas.

4.2. Projections of rice supply

4.2.1. Rice yield function and projection of rice yields

It is assumed that rice yield function can be specified as follows:

$$q_t = c_0 + c_1 T^{1/2} + c_2 \mathrm{SA}_t + c_3 P_{rt-1} + \sum_{i=4}^{n} c_i P_{it-1} + v_t \tag{9}$$

where q is rice yields per 1 ha, T is time trend, SA is rice diversion areas, P_{r} is farm gate rice prices, P_{i} is input prices. c_i (i is 0, 1,...,n) are parameters, and v is a disturbance term. Annual data for the period 1970–1992 are used to estimate the rice yield function. Time trend T takes 1 for 1970 through 23 for 1992.

Since parameter estimates of output prices and input prices are not different from zero at the 5%

[6] In our study, year-end stocks in year $t+1$ is fixed at 1.365 mmt; the target rice production in year $t+1$ is then calculated by the equation $Q_{t+1}^* = C_{t+2} - M_{t+2}$.

significance level, these price variables are eliminated from the explanatory variables, and the final estimation result of the rice yield function is as follows:

$$q_t = \underset{(361.299)}{398.723} + \underset{(46.535)}{18.181T^{1/2}} + \underset{(6.041)}{0.014\text{SA}_t} \qquad (10)$$

$\bar{R}^2 = 0.995$ D.W. = 1.313

The estimation result shows that rice yields are positively related to rice diversion areas. This is because farmers tend to divert paddy fields of lower land productivity from rice production, thus improving average rice yields of the remaining rice land. Rice yields are positively related to the square root of time, implying that rice yields have been increasing due to technological changes, but the growth rate of rice yields has slowed down over time.

Future rice yields are projected based on the estimated parameters of Eq. (10), and projection result is shown in Table 3. Rice yields are projected to increase at declining rates. The average annual increase in rice yields during the projection period is 14 kg/ha, and this annual increase is about a half of that of the period 1970–1992. This decline in growth rate can be partially explained by changes in the rice varieties being produced in recent years. High-quality rice varieties, which do not necessarily give the highest yields, have been chosen by farmers in response to the changes in consumer tastes and relatively higher prices. Farmers can get higher income from the production of high-quality rice varieties than high-yield varieties. Most of Japanese consumers consider rice taste as the most important factor for selecting rice brands at retail stores. This trend of concentration in high-quality rice is expected to continue in the future.

4.2.2. Projection of paddy field areas

Almost all rice is produced in paddy fields in Japan [7]. Therefore, paddy field areas could be considered as the upper limit areas where rice can be grown. Paddy field areas have been declining mainly due to diversion to nonagricultural uses such as housing site, factory site, and abandonment of marginal land, as well as planting of perennial crops. Among these factors diversion of paddy fields to nonagricultural uses has been the predominant factor, implying that demand for paddy fields from the nonagricultural sector has been the most important factor.

To make a projection of future paddy field areas, a paddy field area equation was estimated by using time series data of the period 1980–1992 [8]. It was found that paddy field areas have been declining at 0.7% per annum over the estimation period. Future paddy field areas are assumed to decline at the same rate, and projected future paddy field areas are shown in Table 3. Paddy fields are projected to decline in the range of 15 000–20 000 ha per annum, and will be 2.471 million ha in 2010.

4.2.3. Rice import

As a result of the GATT Uruguay Round agreement, Japan is required to become a regular rice importer. Since there will be an excess supply capacity of rice in Japan (in the sense that if rice is planted in all paddy fields, rice production will be far above the domestic rice demand), rice imports will be limited to the MA imports.

The GATT accord allows Japan to exempt rice from tariff imposition for the period 1995–2000, and it also requires additional and acceptable concessions to have the grace period extended. In this study, we assume that the Japanese government continues the MA rice import scheme for the period 2001–2010. Two cases are assumed with respect to import quantities for this period. First, rice imports are assumed to increase at the same rate as that of the period 1995–2000, i.e., 0.8% increase per annum, and in-

[7] About 0.16% of rice is produced in upland fields in 1994.

[8] Paddy field area equation is specified as follows: paddy field area are the function of time, rice income, wage rates of all industries. This function is estimated by OLS using time series data. Parameter estimates of time are significantly different from zero, but parameter estimates of rice income and wage rates of all industries are not different from zero at the 5% significant level. Hence, paddy field areas are regressed only on time, and gave the following result.

$$\text{LnPF} = \underset{(15946.235)}{8.032} - \underset{(-111.608)}{0.007T}$$

$\bar{R}^2 = 0.999$ D.W. = 0.492

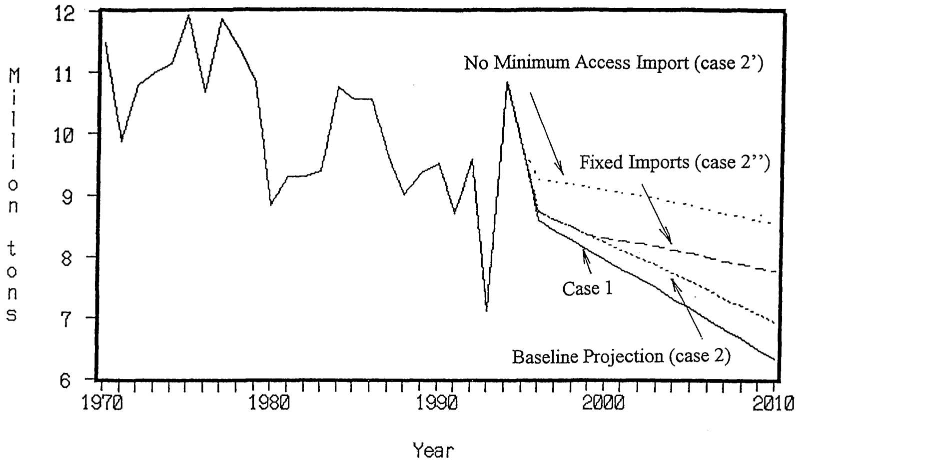

Fig. 2. Projection of total rice production (milled rice).

crease to 1.515 mmt by 2010 [9]. This assumption is called as case 2. An alternative assumption is that rice imports for the period 2001–2010 are fixed at the year 2000 level, i.e., 0.758 mmt, and this assumption is called case 2″.

4.2.4. Projection of rice production and rice diversion areas

Fig. 2 shows the projection results of the target rice production calculated using Eq. (7). Target rice production in case 2, which corresponds to a relatively lower growth in income and continuation of the MA import until 2010, is higher than that in case 1 over the entire projection period. In the case 2 projection, target rice production is predicted to decline steadily from 9.73 mmt in 1995 to 6.92 mmt by 2010. In the case 1 projection, target rice production is predicted to decline from 9.73 mmt in 1995 to 6.33 mmt in 2010. Rice production in the case 2 projection is 0.59 mmt higher than that in the case 1 projection in 2010. While if rice imports are fixed at 0.758 mmt for the period 2001–2010, target rice production is projected to be 7.77 mmt in 2010, 0.849 mmt higher than the case 2 projection.

To assess the effects of the partial opening of the rice market, future target rice production is projected without the MA rice import, and this is called case 2′ projection. In this case, rice production is predicted to decline from 9.73 mmt in 1995 to 8.54 mmt in 2010, and exceeds the case 2 projection by 1.62 mmt in 2010 [10].

Future target rice diversion areas are calculated as the difference between projected paddy field areas and target rice planted areas, and projection results are shown in Table 3 and Fig. 3. In the case 2 projection, target rice diversion areas show a sharp increase in 1996 due to the excess supply of rice caused by the large amount of emergency rice imported in 1993 and 1994, and by the bumper crop of 1994. It may not be easy to achieve the diversion target of 826 000 ha in 1996. If actual rice diversion areas were less than the target diversion areas, then ending rice stocks may be more than 1.365 mmt [11]. In the case 2 projection, rice diversion area are

[9] Considering that the amount of Japonica rice traded in the international market is about 2 mmt as of the mid-1990s, the increase in Japonica rice import by Japan would result in an increase in the international prices for medium-grain Japonica type rice in the medium- to long-run. According to the projection results by Wailes et al. (1995) the international price for medium-grain Japonica type rice (California FOB) is expected to increase from 427 dollars per mt in 1996 to 550 dollars per mt in 2010.

[10] It is calculated dividing the minimum access import by projected rice yields.

[11] Rice stocks at the end of Rice Year 1996 have increased to 2.68 mmt, which is about twice the desired level, and is expected to increase to 2.7–2.8 mmt by the end of Rice Year 1997. Part of the reason for this excess rice stock is that actual rice diversion areas in 1996 were less than our projected target rice diversion areas.

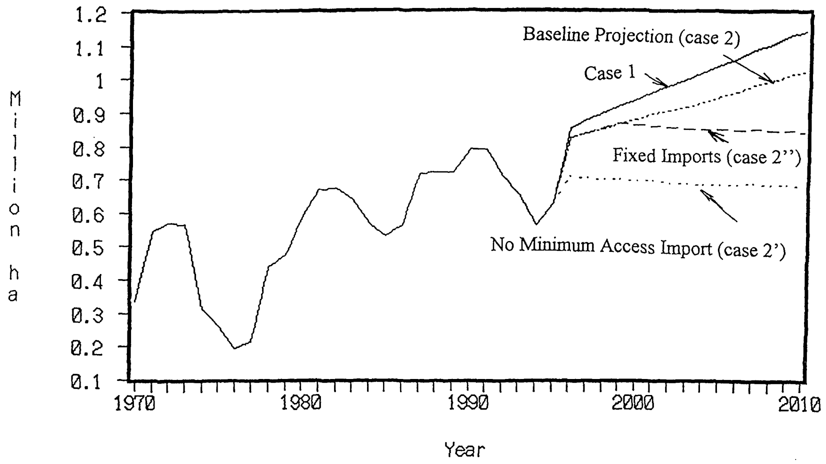

Fig. 3. Projections of rice diversion areas.

predicted to be 878 000 ha in 2000, and increase to 1.02 million ha by 2010. In the case 1 projection, rice diversion areas are predicted to be 940 000 ha in 2000, and increase to 1.145 million ha by 2010. The case 2′ projection shows that, without the MA import, rice diversion areas remain around the 1993 level.

Compared with the case 2 projection, rice diversion areas without the MA rice import are smaller by 183 000 ha in 2000, and 339 000 ha in 2010. If rice imports are fixed at 758 000 metric tons during the period 2001–2010 (case 2″), rice diversion areas are projected to be 862 000 ha in 2000, and thereafter remain rather stable in the range of 844 000–861 000 ha.

4.3. Policy implications of simulation results

Simulation results show the need to increase the rice diversion areas from 588 000 ha in 1994 to 1.02 million ha in 2010 in the case 2 projection. This is a 74% increase over the next 16 years. The government will encounter many difficulties in achieving the target of the rapidly increasing rice diversion areas. To facilitate the achievement of the target rice diversion areas, the government pays rice diversion subsidies to rice farmers who participate in the rice diversion program. However, the rice diversion subsidy per unit of paddy field has been declining since the early 1980s. Therefore, the farmers' economic incentive to divert paddy fields to alternative crops is getting weaker over time. Many farmers are reluctant to increase rice diversion areas any more. Since participation in the program is no longer mandatory, there is a possibility that the farmers' participation rate will decline in the future. If the participation rate declines and rice production increases, then domestic rice price will fall quickly because the price elasticity of rice is small. As a result, large-scale rice farmers will suffer from a sharp drop in income, and may move out of rice production. Some small-scale part-time farmers who do not rely so much on rice income may maintain rice production mainly for their own consumption.

5. Conclusion

The Japanese government partially opened the rice market in 1995, and Japan became a regular rice importer. Japan will be one of the largest rice importers in the world around 2000.

Rice is an inferior commodity in Japan, and per capita rice consumption for table use has been in continuous decline, from 118.3 kg in the peak year of 1962 to 69.7 kg in 1992. Although the rate of decline has been falling since the latter half of the 1980s, the trend of gradual decrease is still expected to continue. In the case 2 projection, per capita rice consumption for table use is expected to decline to 60 kg by 2010.

The future rice yields are projected to increase at declining rates. This improvement of land productivity further increases the potential rice production capacity in Japan. The MA rice import also increases the rice supply. These two factors, as well as declining future rice consumption, result in the need for expansion of rice diversion areas. In the case 2 projection, target rice diversion areas are projected to increase to 878 000 ha by 2000, rising to 1.021 million ha by 2010, which results in a 74% increase, taking the rice diversion areas in 1994 as a base. Of this 1.021 million ha in 2010, 339 000 ha is attributed to the MA rice import. Many farmers are reluctant to increase the rice diversion areas. In 1996, 12 prefectures failed to achieve the allocated rice diversion areas, and if the rice diversion areas have to be expanded in the future, the number of prefectures that cannot achieve the allocated rice diversion areas will increase, resulting in the achievement rate of the diversion target to drop below 100%. If the participation rate of the rice diversion program declines, and rice production increases, market prices will fall fast because the price elasticity of rice is small. As a result, large-scale rice farmers will suffer from a sharp drop in income, and they may move out of rice production. It will then be very difficult to materialize the outlook for the agricultural structure described in the Basic Direction of New Policies for Food, Agriculture and Rural Areas, in which large scale individual farm management bodies and organized farm management bodies are expected to produce about 80% of the total rice. To reduce the excess rice stocks and prevent the rapid increase in the rice diversion areas, the introduction of a surplus rice disposal program, rice exports on concessionary terms, and the development of new rice demand such as industrial use will be necessary. However, these measures will cause an increase in the financial burden of the government.

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