

**Agricultural Economics Report No. 433**

**December 1999**

**Outlook of the World Rice Industry  
Under Alternative Trade Liberalization Policies  
in Japan and Korea**

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## Acknowledgments

The authors extend appreciation to Dr. William Nganje, Mr. Tim Petry, and Mr. Andy Swenson for their constructive comments and suggestions. Special thanks go to Ms. Carol Jensen, who helped to prepare the manuscript.

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## Highlights

Rice is the most widely used food grain in the world. Production and consumption of rice are concentrated in Asia, Northern Africa, and Middle Eastern regions. As a result of gradual increases in population and steady economic growth in the regions, rice consumption has increased faster than production, resulting in slight increases in the price of rice in the world market for the last decade.

The world rice economy is becoming more market oriented as a result of several multilateral trade negotiations, such as the Uruguay Round (UR) agreement (1995), and regional trade initiatives. In addition, another round of the World Trade Organization (WTO) trade negotiations will start in the near future. Impacts of these changes on rice production and trade flows in the world rice industry are unknown.

The overall objective of this study is to analyze supply and demand fundamentals for rice in the world market under alternative trade liberalization policies in Japan and Korea and implications on the world rice economy.

A global rice policy simulation scenario was developed by dividing rice into japonica and indica rice. This scenario includes 12 major rice producing and consuming countries. These countries are Australia, China, India, Indonesia, Japan, Korea, Myanmar, the Philippines, Taiwan, Thailand, the United States, Vietnam, and the rest of world. Since the United States and China produce and consume both indica and japonica rice, substitution between these two rice in production and consumption in these two countries is allowed in the scenario. It is assumed that Australia, Japan, Korea, and Taiwan produce and consume only japonica rice. Other countries are assumed to produce and consume only indica rice.

Production, consumption, and carry-over stock equations of each type of rice in major producing and consuming countries are estimated with time series data by using econometric techniques. The estimated equations are linked under a partial equilibrium condition in the world rice industry to analyze rice production, consumption, carry-over stocks, and exports or imports in the countries. In the market clearing condition, the sum of aggregate excess demand equations for japonica and indica rice, which are a function of prices of japonica and indica rice, are equal to zero. These two equations are solved for the equilibrium price of japonica and indica rice.

The study is based on the baseline and trade liberalization scenarios. The baseline scenario is based on the most likely assumptions on macroeconomic conditions and trade policies in the countries in the scenario. The trade policies are mainly individual countries' commitments under the UR agreement. On the other hand, the partial trade liberalization scenario includes a partial liberalization of rice imports in Korea and Japan from the year completing the minimum market access commitments under the UR agreement to 2010. The import liberalization periods are 2001-2010 for Japan and 2004-2014 for Korea. The full trade liberalization scenario includes a full liberalization of rice imports in Korea and Japan from the year completing the minimum market access commitments under the UR agreement to 2010 in Japan and 2014 in Korea. The results of this study are summarized as follows:

## **1. The Price of Indica and Japonica Rice under the Base Scenario**

In general, consumption for both japonica and indica rice is expected to be larger than production of the rice, resulting in gradual increases in the price of the rice. The price of indica rice is predicted to increase about 10.3 percent from \$310/mt in 1998 to \$342/mt in 2010. However, the price of japonica rice is expected to decrease slightly. The price of japonica rice will decrease 1.7 percent from \$477/mt to \$469/mt in the same period due mainly to expected decreases in per capita rice consumption in Korea and Japan. As a result, the price spread between these two rice in 1998 is smaller than that in 2010.

## **2. The World Indica Rice Industry under the Base Scenario**

China was the largest producer of indica rice followed by India in the 1995-97 period. However, India is expected to approach the production level in China in the next 10 years. Indonesia will be the third largest producer of indica rice. The U.S. production of indica rice is expected to grow faster than in any other indica rice producing countries for the 1998-2010 period, followed by Vietnam.

Aggregate consumption of indica rice in China was 97 million metric tons (mmt) annually in the 1995-97 period. China's consumption is projected to increase 5.3 percent through 2010. India consumed 79.6 mmt per year during the 1995-97 period and its consumption is projected to increase 23.0 percent through 2010. The increase in consumption is due mainly to expected increases in population during the same period. Aggregate consumption of indica rice in Indonesia and Vietnam also is projected to increase 17.7 percent and 24.6 percent, respectively, through 2010.

Thailand was the largest exporter of indica rice, followed by Vietnam and India for the 1995-97 period. Thailand exported 5.6 mmt in the 1995-97 period and its exports are projected to increase 34.0 percent by 2010. Vietnam and India exported 3.2 mmt and 2.6 mmt of indica rice, respectively, in the 1995-97 period. Their exports are projected to increase 57.2 percent and 22.6 percent, respectively, by 2010. The U.S. exports of indica rice were 2.4 mmt and are projected to increase 95.3 percent by 2010.

Major importing countries of indica rice have been China, Indonesia, and the Philippines. Indonesia was the largest importer, followed by the Philippines during the 1995-97 period. However, the quantities of indica rice imported by the countries are expected to change during the 1998-2010 period. China is predicted to decrease its imports, while Indonesia increases its imports slightly.

## **3. World Japonica Rice Industry under the Base Scenario**

China has been the largest producer of japonica rice, followed by Japan. China produced 33.1 mmt annually in the 1995-97 period, which is much smaller than the production of indica rice (95 mmt). However, production of japonica rice in China is projected to increase by 17.0 percent through 2010, which is faster than the production growth rate of indica rice. Japan produced 8.9 mmt of japonica rice per year during the 1995-97 period and production is projected to decrease by 6.7 percent through 2010. South Korea produced 4.8 mmt annually for the 1995-97 period and production is projected to

decrease 2.2 percent through 2010. The United States and Australia are expected to increase their japonica rice production substantially to meet import demand for japonica rice in Japan and Korea. The U.S. production of japonica rice is projected to increase 29.4 percent to 3.2 mmt in 2010 while Australia's production is projected to increase 58.4 percent to 1.3 mmt.

China consumed 33.2 mmt of japonica rice annually in the 1995-97 period, and its consumption is projected to increase 18.2 percent through 2010. Aggregate consumption of japonica rice in Japan was 9.2 mmt per year in the 1995-97 period and is projected to decrease 3.9 percent through 2010. Consumption in Korea was 5.1 mmt per year in the 1995-97 period and is projected to increase 1.8 percent through 2010. Consumption in the United States is projected to increase 16.4 percent through 2010.

The United States has been the largest exporter of japonica rice, followed by Australia. U.S. exports of japonica rice were 0.82 mmt annually in the 1995-97 period and are projected to increase 28.8 percent by 2010. Australia exported 0.54 mmt per year in the 1995-97 period and is projected to increase exports 81.4 percent by 2010. China is projected to become an importer of japonica rice by 2010.

Japan was the largest importer of japonica rice in the 1995-97 period. Japan is expected to import 1.41 mmt in 2010, which is about 16.0 percent of the expected domestic consumption. Korea is expected to increase its imports during the 1998-2010 period. Its imports are expected to be 0.52 mmt, which is about 10 percent of the expected domestic consumption in 2010.

#### **4. The World Indica and Japonica Rice Industry under the Alternative Trade Liberalization Scenarios**

Under the trade liberalization scenarios in which Japan and Korea liberalize its rice imports by the year 2010 and 2014, respectively, the world price of japonica rice is expected to be higher than that under the base scenario for the 1998-2010 period while the price of indica rice is similar to that under the base scenario. The price of japonica rice is expected to increase 13.8 percent from \$477/metric ton to \$542/metric ton in 2010 under the partial trade liberalization scenario and 19.7 percent under the full liberalization scenario.

Japan and Korea are expected to reduce their japonica rice production under the scenarios, compared to that under the base scenario. Japan is expected to decrease rice production from 8.3 mmt under the base scenario to 7.7 mmt under this scenario in 2010, and Korea is expected to decrease its production from 4.7 mmt to 4.4 mmt under the partial liberalization scenario. Under the full liberalization scenario, rice production is expected to decrease 22 percent in Japan and 13 percent in Korea. On the other hand, the United States and Australia are expected to increase their japonica rice production in this scenario, compared to under the base scenario.

The impacts of the import liberalization policies on the production of indica rice are much smaller than that on japonica rice production. The United States and China are expected to reduce production of indica rice to produce more japonica rice. Other countries maintain their production of



indica rice at similar levels under the scenarios mainly because the countries have produced only indica rice and have very limited capability to switch to japonica rice production even though the price of japonica rice is higher than that of indica rice.

Japan and Korea are expected to increase their imports significantly through 2010 in this trade liberalization scenario. Japanese imports of japonica rice are expected to increase more than 28 percent from 0.41 mmt in the base scenario to 1.8 mmt in the partial trade liberalization scenario in 2010 and Korean imports will increase 29 percent, from 0.52 mmt to 0.86 mmt. The imports of japonica rice in Korea and Japan would be 16.2 percent and 20.6 percent of their expected domestic consumption in 2010, respectively. Under the full liberalization scenario, imports of japonica rice in Korea and Japan would be 22.9 percent and 24.3 percent of their expected domestic consumption in 2010, respectively. On the other hand, the United States and Australia are expected to increase their exports of japonica rice during the 1998-2010 period in the partial trade liberalization scenario, compared to the base scenario. There are no significant changes in exports of indica rice in the trade liberalization scenario, compared to the base scenario, except in the United States and China. The United States is expected to decrease exports of indica rice in the scenario, compared to the base scenario, while China is expected to increase imports of indica rice.

This study clearly reveals that trade liberalization plans in Korea and Japan may not affect the world rice industry substantially. However, the policy changes will substantially reduce domestic price of japonica rice and net farm income in both Japan and Korea and will increase the world price of japonica rice.

## **Abstract**

This report evaluates the world rice industry for the 1998-2010 period by using the World Rice Policy Simulation Model. This analysis is based on a series of assumptions about general economic conditions, agricultural policies, the weather, and technological change.

This report evaluates three scenarios: the base scenario, the partial trade liberalization scenario in Japan and South Korea, and the full trade liberalization scenario. The partial trade liberalization scenario includes a partial liberalization of rice imports in Japan and South Korea from the year completing the minimum market access commitments under the UR agreement to 2010. The full trade liberalization scenario includes a full liberalization of rice imports in Japan and South Korea from the year completing the minimum market access commitments under the UR agreement to 2010 in Japan and 2014 in South Korea.

Both trade liberalization scenarios result in higher world rice price for both japonica and indica rice and lower domestic rice price and production in both Japan and South Korea.

**Key Words:** Japonica Rice, Indica Rice, Trade Liberalization, Production, Consumption, Imports, Exports

# Outlook of the World Rice Industry Under Alternative Trade Liberalization Policies in Japan and Korea

Won W. Koo and Richard D. Taylor\*

## 1. Introduction

Rice is the most widely used food grain in the world. Production and consumption of rice are concentrated in Asia, Northern Africa, and Middle Eastern regions. As a result of gradual increases in population and steady economic growth in the regions, rice consumption has increased faster than production, resulting in slight increases in the price of rice in the world market for the last decade.

The world rice economy is becoming more market oriented as a result of several multilateral trade negotiations and regional trade initiatives. The Uruguay Round (UR) agreement (1995) requires: (1) market access - the opening of rice markets in Japan, South Korea, and other countries, (2) reductions in aggregate support levels, and (3) reductions in export subsidies, mainly in the United States and the European Union. The UR agreement could result in further specialization of rice production on the basis of the principle of comparative advantage characterized by resource endowments in rice producing countries. This implies that there will be an increase in trade volume of rice in the world market under the post-UR era. In addition, regional trade initiatives, such as the North American Free Trade Agreement (NAFTA) and the free trade agreement in South America (Mercosur), which includes Argentina, Brazil, Paraguay, and Uruguay, are already changing global rice trade. The 2000 round of the World Trade Organization (WTO) trade negotiations will start in the near future. Impacts of these changes on rice production and trade flows on the world rice industry are unknown.

Rice is divided into two major varieties: japonica and indica. Japonica rice is mainly produced and consumed in Australia, China, Japan, South Korea, Taiwan, and the United States (Table 1). Major exporting countries of japonica rice are the United States and Australia and major importers are Japan and Korea.

Indica rice is largely produced and consumed in China, India, Indonesia, Myanmar, the Philippines, Thailand, and Vietnam. Major exporting countries of indica rice are India, Thailand, Vietnam, and the United States, and importers are Indonesia, the Philippines, and China. Japonica and indica rice have limited substitution for food use, but are highly substitutable for industrial use. On the production side, most rice producing countries are specialized in producing a variety of rice based on their domestic demand preference. The United States and China produce and consume both japonica and indica rice.

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**Table 1. The 5-Year Average Production, Consumption, and Import/export of Indica and Japonica Rice**

Country	Production	Consumption	Import/export
<u>Indica Rice</u> -----1,000 metric tons-----			
			---
China	93,651	97,180	(700)
India	81,260	79,702	2,884
Indonesia	32,897	33,878	(1,957)
Vietnam	17,635	14,432	3,102
Thailand	14,876	8,640	5,707
Myanmar	9,416	9,204	260
Philippines	7,042	7,802	(713)
United States	5,945	3,066	2,849
<u>Japonica Rice</u>			
China	32,897	33,309	26
Japan	9,133	9,197	(335)
S. Korea	4,843	5,117	(62)
United States	2,522	1,781	789
Taiwan	1,466	1,396	98
Australia	839	291	556

Korea will import at least 5 percent of its domestic consumption by 2004 under the Uruguay Round agreement. However, Korea's rice import may exceed its commitment under the agreement. This is due mainly to expected rapid reductions in arable land for rice production in the country. Although rice yields are expected to increase due to improvement in agricultural technology, the reductions in arable land may result in decreases in rice production in the country. On the consumption side, per capita rice consumption in Korea has been decreasing over the last decade due mainly to increases in per capita income. Because of the recent economic crisis in Korea; however, rice consumption may not decrease as predicted for the next few years, but will maintain a decreasing trend. Rice production may decrease faster than consumption in Korea, resulting in increases in rice imports.

This also may be true in Japan and China. Japan will import at least 5 percent of its rice consumption by 2000 under the Uruguay Round agreement. China may also become an importer of japonica rice.

The overall objective of this study is to analyze supply and demand conditions of rice in the world market under the alternative trade liberalization policies in Japan and Korea and implications on the world rice economy. Specific objectives are:

1. To predict supply and demand for rice in the world market and its implications on changes in world rice price under the given agricultural and trade policies.
2. To analyze the impacts of changes in the trade liberalization policies in Korea and Japan on the world rice industry.

The objectives will be accomplished by developing a global rice policy simulation model. Several rice models are available in the United States. Wailes et al. developed the Arkansas global rice model, which contains 20 major rice producing and consuming countries. Food and Agricultural Policy Research Institute (FAPRI) also has a global rice model. The U.S. Department of Agriculture has a global multi-commodity model in which rice is one of commodities. However, these models did not divide rice into japonica and indica rice. As a result, the models may suffer an aggregation bias for the individual rice industries (Yang and Koo). The proposed study develops a global rice model dividing rice into japonica and indica rice.

## **2. Model Structure and Development**

A dynamic global rice simulation model is developed to accomplish the stated objectives. Rice is divided into two different classes in terms of end-use; japonica and indica. This model includes major rice producing and consuming countries. Major rice producing and consuming countries used in this study are Australia, China, India, Indonesia, Japan, Korea, Myanmar, the Philippines, Taiwan, Thailand, the United States, Vietnam, and the rest of world. Since the United States and China produce and consume both indica and japonica rice, substitution between these two rice in production and consumption in the two countries is allowed in the model. It is assumed that Australia, Japan, Korea, and Taiwan produce and consume only japonica rice. Other countries are assumed to produce and consume only indica rice.

Rice production, consumption, and carry-over stock equations in major producing and consuming countries are estimated with time series data by using econometric techniques. The estimated equations are linked under a partial equilibrium condition in the world rice industry to analyze rice production, consumption, carry-over stocks, and exports or imports in the countries (Figure 1). In the market clearing condition, the sum of aggregate excess demand equations for japonica and indica rice, which are a function of price of japonica and indica rice, are equal to zero. These two equations are solved for the equilibrium price of japonica and indica rice.

### **Rice Supply**

Area and yield equations for rice are estimated to calculate the supply of rice. Since rice is divided into two classes (japonica and indica), two separate supply equations are estimated in the United States and China, which produce both rice classes. Other countries produce either japonica or indica rice. Thus, these countries have behavioral equations for one rice class which is produced under an assumption that the two rice are not substitutable in production and consumption in the countries.

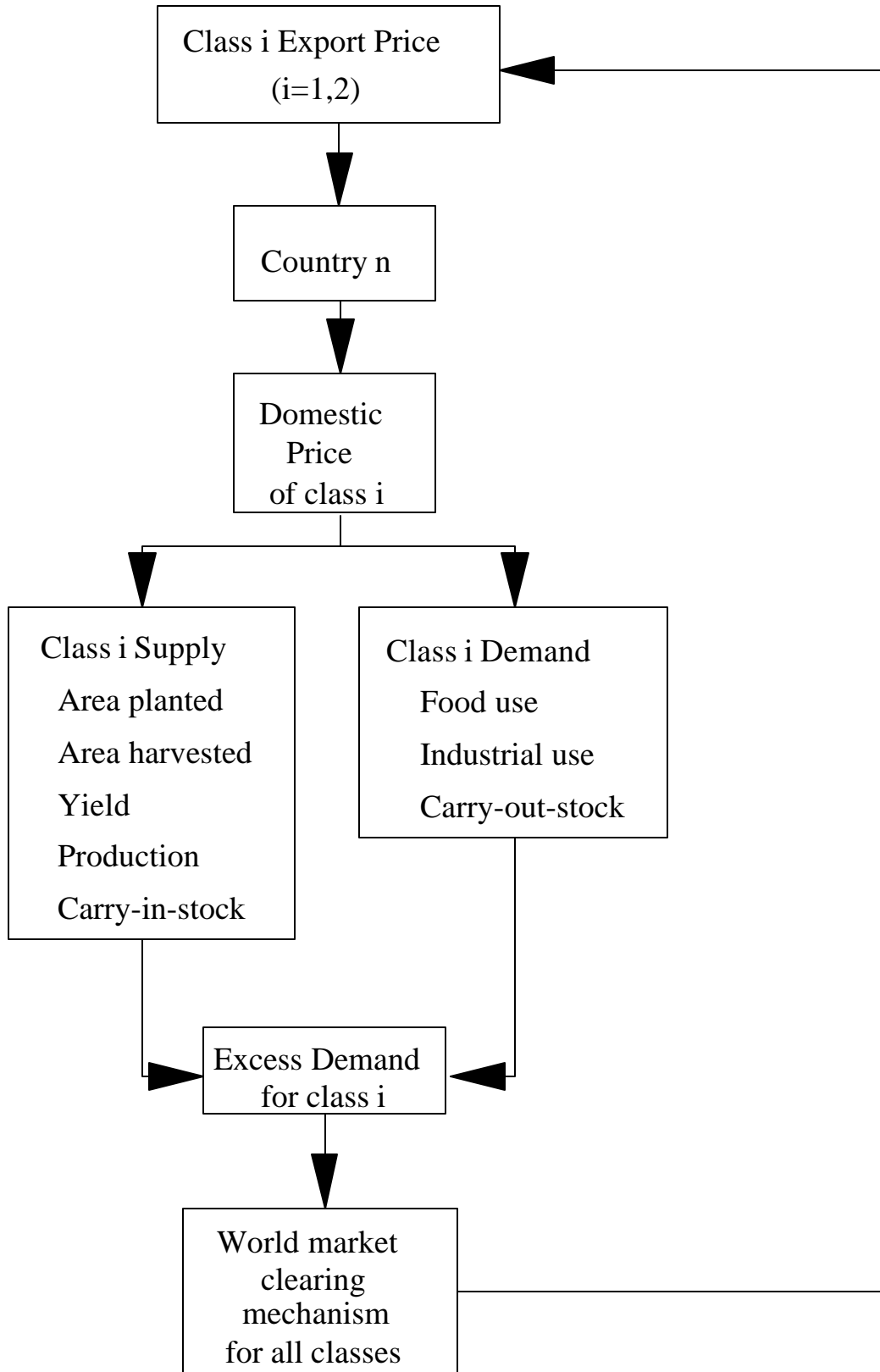


Figure 1. Conceptual Rice Model.

### Area Harvested

Rice area depends upon expected prices of rice and alternative crops. As a proxy variable of price expectations, lagged prices are used in the area equation. In addition to commodity prices, the lagged area variable is included to capture dynamics associated with producers' planting decisions. The area harvested is a function of lagged area, prices of rice and alternative crops, and government policies as follows:

$$a_{i,t}^r = f(a_{i,t-1}^r, p_{1,t-1}^r, p_{2,t-1}^r, p_{t-1}^c, g_t) \quad (1)$$

where

- $a^r$  = the rice area harvested
- $p^r$  = the world market or domestic price of rice
- $p^c$  = the price of alternative crops
- $g$  = policy parameters
- $i$  = index for rice type ( $i = 1$  for japonica and  $i = 2$  for indica)

For the United States and China, in which both indica and japonica are produced, area of one type of rice is a function of price of both rice types under an assumption that these two types of rice are substitutable in production. However, the model does not allow the substitution between these two rice types in other countries. This implies that area of indica rice is a function of the price of indica rice, and area of japonica rice is a function of the price of japonica rice. Australia, Korea, Japan, and Taiwan produce only japonica rice and other countries produce only indica rice.

### Yield

Rice yields depend on lagged yield and a time trend representing changes in technology as

$$y_{i,t}^r = f(y_{i,t-1}^r, t) \quad (2)$$

where

- $y^r$  = rice yield per hectare
- $t$  = a time trend representing technology.

### Production

The total quantity of rice produced is the product of the area harvested and yield per hectare as follows:

$$qp_{i,t}^r = a_{i,t}^r \cdot y_{i,t}^r \quad (3)$$

where

- $qp_{i,t}^r$  = the quantity of rice produced

## Rice Demand

Demand for rice comprises food and industrial uses for domestic demand, carry-out stocks, and net exports. Domestic demand and carry-out stock equations are estimated with time series data, while net exports are the difference between domestic demand and supply.

### Domestic Consumption

Per capita rice consumption is divided into food and industrial consumption. Per capita demand for food is a function of its own price of rice, income, and a time trend representing changes in consumers' tastes and preferences, while rice consumption for industrial use depends on the price of japonica and indica rice, income, and a time trend:

$$fd_{i,t}^r = f(p_{i,t}^r, cy_t, t) \quad (4)$$

$$id_{i,t}^r = f(p_{1,t}^r, p_{2,t}^r, cy_t, t) \quad (5)$$

The total consumption of rice in a country is calculated by multiplying the per capita consumption by population in the country as

$$qd_{i,t}^r = (fd_{i,t}^r + id_{i,t}^r) * pop_t \quad (6)$$

where

fd = demand for food  
id = demand for industrial uses  
qd = the total demand for rice  
cy = per capita income  
pop= population

Substitution between indica and japonica rice in consumption is allowed in the United States and China, mainly because these two countries produce and consume the two types of rice. Other countries are assumed to consume either japonica or indica rice.

### **Carry-out Stocks**

Carry-out stock is a precaution against unexpected shortfalls in production. These stocks, therefore, are likely related to the level of domestic production. However, since the opportunity cost of holding rice stocks depends on the price of rice, the stocks should respond to price changes.

$$qs_{i,t}^r = f(qs_{i,t-1}^r, qp_{i,t}^r, p_{i,t}^r) \quad (7)$$

where  $qs^r$  = carry-out stocks.



## Net Export

Net exports are the difference between domestic supply and demand:

$$qx_{i,t}^r = qs_{i,t-1}^r + qp_{i,t-1}^r - qd_{i,t}^r - qs_{i,t}^r \quad (8)$$

where  $qx^r$  = the net export of rice.

If net exports are negative, the country is a net importer.

## Price Linkage

World price of rice is converted into domestic price using the official exchange rates as follows:

$$pm_{i,t}^{r,n} = pm_t^{r,w} * er_t^n \quad (9)$$

where

$pm^{r,n}$  = import price of rice in country n

$pm^{r,w}$  = world price of rice

$er^n$  = exchange rate

To simulate changes in trade policies, specific and ad valorem tariffs can be added to the linkage equation as:

$$pd_{i,t}^{r,n} = pm_{i,t}^{r,n} \cdot (1 + b^{r,n}) + t^{r,n} \quad (9)$$

where

$pd^{r,n}$  = domestic price of rice paid by consumers

$b$  = an ad valorem tariff

$t$  = specific tariff

The wholesale price of rice is linked to the world price of rice in domestic currency:

$$pw_{i,t}^{r,n} = f(pd_{i,t}^{r,n}) \quad (10)$$

where  $pw^{r,n}$  = wholesale price of rice.

The price of rice received by farmers is linked to the world price of rice in domestic currency:

$$pf_{i,t}^{r,n} = f(pd_{i,t}^{r,n}) \quad (11)$$

where  $pf^{r,n}$  = price of rice received by farmers.

## Market Equilibrium

The market equilibrium implies that the total supply equals total demand, indicating that the sum of each country's excess demand (exports) is equal to zero:

$$\sum_{n=1}^n q x_{i,t}^{r,n} = 0 \quad i = 1,2 \quad (11)$$

The equilibrium condition is solved to determine the market clearing price of japonica and indica rice. For the countries which have import commitments under the UR agreement (Japan and Korea), their actual import commitments are used in the above equations when their imports are less than the commitments.

## Model Calibration

All behavioral equations of the model are calibrated to the base period by adjusting the intercept term as follows. Consider the following estimated behavioral equation:

$$y = \hat{\beta}_0 + \hat{\beta}_1 x \quad (12)$$

where  $y$  is the dependent variable and  $x$  is the independent variable.

The intercept term can be re-calculated at the base period to calibrate the equation to the base period as follows:

$$\tilde{\beta}_0 = y^* - \hat{\beta}_1 x^*$$

where  $y^*$  and  $x^*$  are values of  $y$  and  $x$  in the base period.

The equation used for simulation is:

$$y = \tilde{B}_0 + \hat{B}_1 x$$

## Data Collections and Macro Assumptions

Baseline projection of this global rice simulation model is grounded on a series of assumptions associated with general economy, agricultural policies, the weather, and technological changes in exporting and importing countries. Macroeconomic assumptions are based on forecasts prepared by WEFA group and Project LINK. Some of the macro variables are GDP growth rates, interest rates, exchange rates, and inflation rates in importing and exporting countries. It is generally assumed that current agricultural policy will be continued in Korea and other trading countries. Average weather conditions and historical rates of technological change are also assumed to prevail during the projection period.

The price of rice in individual countries and the world market is endogenous, while the prices of other crops are exogenous. Therefore, the baseline projection of the model is based on the forecasted

world prices of other crops which have substitute and complementary relationships with rice. The forecasted prices were obtained from the FAPRI baseline solution.

Data associated with harvested area, yields, consumption, carry-over stocks, and government policies in individual countries were obtained from various sources, including *Rice: Situation and Outlook Report* (USDA), *Agricultural Supply and Demand* (USDA), *Australia Agricultural Statistics*, and *Chinese Agricultural Statistics*.

### **3. Results**

The study is based on the baseline and trade liberalization scenarios. The baseline scenario is based on the most likely assumption on macroeconomic conditions and trade policies in the countries in the model. The trade policies are individual countries' commitments under the UR agreement. On the other hand, this study developed two trade liberalization scenarios (1) partial trade liberalization of rice imports in Korea and Japan from the year completing their minimum market access commitments under the UR agreement to 2010 and (2) full trade liberalization of rice imports in Korea and Japan from the year completing their minimum market access commitments under the UR agreement to 2010. The import liberalization period is 2001-2010 for Japan and 2005-2014 for Korea. Because of differences in the trade liberalization schedule between these two countries, results presented in this study are based on completion of the scheduled liberalization process in Japan and 60 percent completion in Korea.

#### **The Baseline Solution**

In general, demand for both japonica and indica rice is expected to be larger than supply of the rice, resulting in gradual increases in the price of the rice. The price of indica rice is predicted to increase about 10.3 percent from \$310/mt in 1998 to \$342/mt in 2010 (Figure 2). However, the price of japonica rice is expected to decrease slightly from \$477/mt to \$469/mt in the same period due mainly to expected decreases in per capita rice consumption in Korea and Japan. As a result, the price spread between these two rice in 1998 is smaller than that in 2010.

#### Rice Production

##### Indica Rice

China was the largest producer of indica rice, followed by India, in the 1995-97 period (Table 2). China's average indica rice production was 94.6 mmt per year in the period, and production is projected to increase by 7.5 percent through 2010. India's indica rice production is expected to increase 24.6 percent by 2010, compared to the 1995-97 average production. As a result, the total production of indica rice in India is expected to approach that in China by 2010. Indonesia is the third largest producer of indica rice. The country produced 33.2 mmt in the 1995-1997 period, and production is projected to increase by 15.5 percent through 2010. Vietnam and Thailand produced 17.8 and 14.9 mmt, respectively, in the 1995-97 period, and production is projected to increase 29.7 percent and 20.1 percent, respectively, through 2010. The United States produced only 5.5 mmt in the 1995-97 period, but production is projected to increase 62.3 percent through 2010. Changes in indica rice production for the 1998-2010 period are also shown in Figure 3. All countries are projected to increase production of indica rice mainly because of gradual increases in yields in the countries.

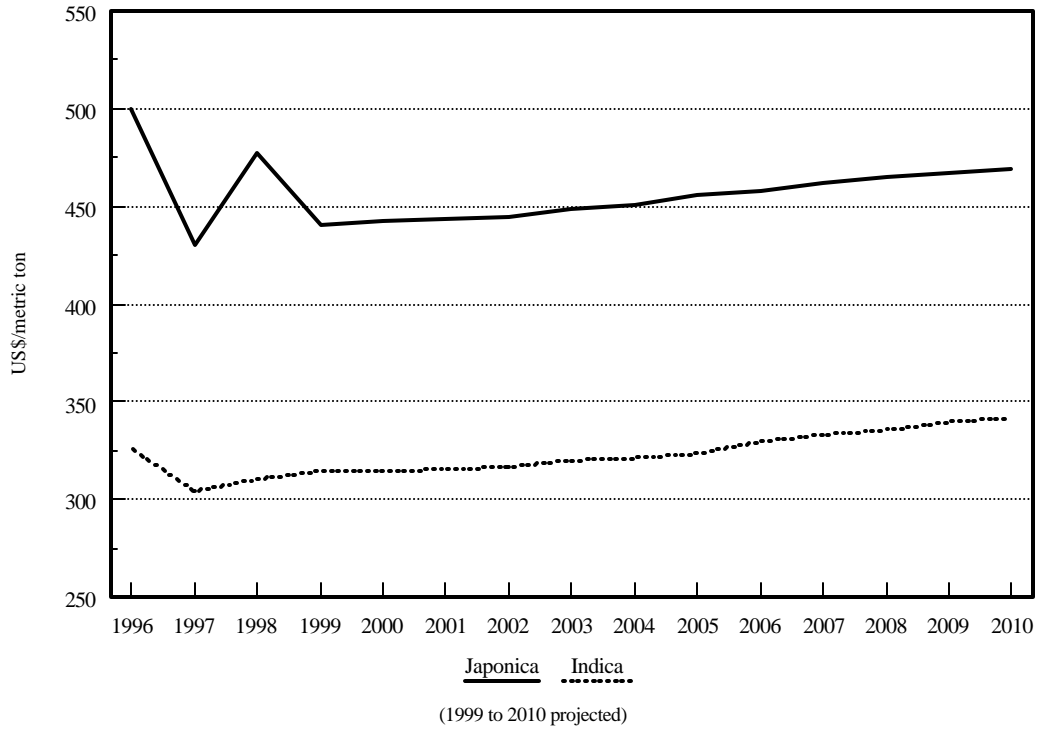


Figure 2. World Export Price of Indica and Japonica Rice under the Base Scenario, 1996-2010.

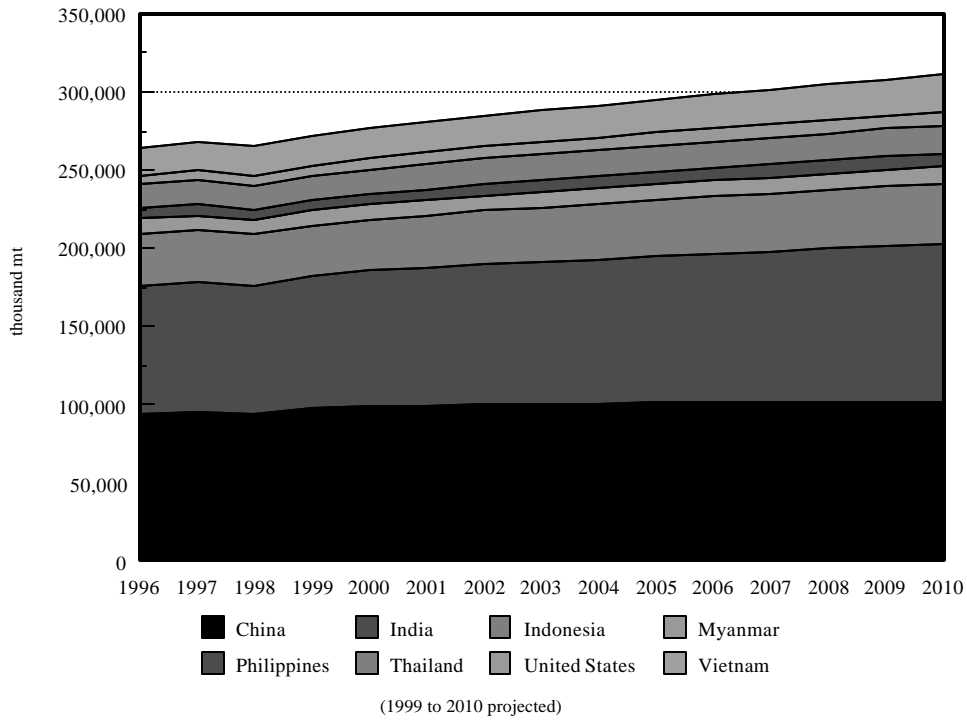


Figure 3. Indica Rice Production in Major Producing and Consuming Countries, 1996-2010.

**Table 2. The Production of Indica and Japonica Rice in Major Producing and Consuming Countries in the Base Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	94,645	94,628	100,544	101,741	7.5
India	81,283	81,292	92,503	101,266	24.6
Indonesia	33,172	32,634	34,988	38,316	15.5
Vietnam	17,846	18,378	20,685	23,152	29.7
Thailand	14,934	15,454	16,545	17,935	20.1
Myanmar	9,367	9,700	10,130	11,163	19.2
Philippines	7,438	6,088	7,598	8,315	11.8
United States	5,530	7,075	8,031	8,974	62.3
<u>Japonica Rice</u>					
China	33,058	33,385	35,244	38,682	17.0
Japan	8,904	8,048	8,350	8,311	-6.7
S. Korea	4,764	4,862	4,692	4,657	-2.2
United States	2,484	2,239	3,139	3,215	29.4
Taiwan	1,469	1,410	1,555	1,553	3.7
Australia	831	888	1,024	1,316	58.4

<sup>1</sup> Compared to the 1995-97 average.

Yields for indica rice in the United States were the second highest in the world (5.58 metric tons/ha) in 1997 and are projected to increase 28.5 percent through 2010. Yields in China were the highest (5.96 metric tons/ha) in 1997 and are projected to increase 6.0 percent through 2010. Yields of indica rice in other countries are lower than those in the United States and China, ranging from 5.5 metric tons/ha in Thailand to 2.81 metric tons/ha in Indonesia in 1997. Yields in these countries are projected to increase about 5 percent through 2010 (Figure 4).

#### Japonica Rice

China is the largest producer of japonica rice, followed by Japan (Table 2). China produced 33.1 mmt in the 1995-97 period, which is much smaller than the production of indica rice (95 mmt). However, production of japonica rice is projected to increase 17.0 percent through 2010, which is faster than the production growth rate of indica rice.

Japan produced 8.9 mmt per year during the 1995-97 period, and production is projected to decrease 6.7 percent through 2010. South Korea produced 4.8 mmt for the 1995-97 period, and production is projected to decrease 2.2 percent through 2010. The United States and Australia are expected to increase their japonica rice production substantially to meet import demand for japonica rice in Japan and Korea. The U.S. production of japonica rice is projected to increase 29.4 percent to 3.2 mmt in 2010 while Australia's production is projected to increase 58.4 percent to 1.3 mmt (Figure 5).

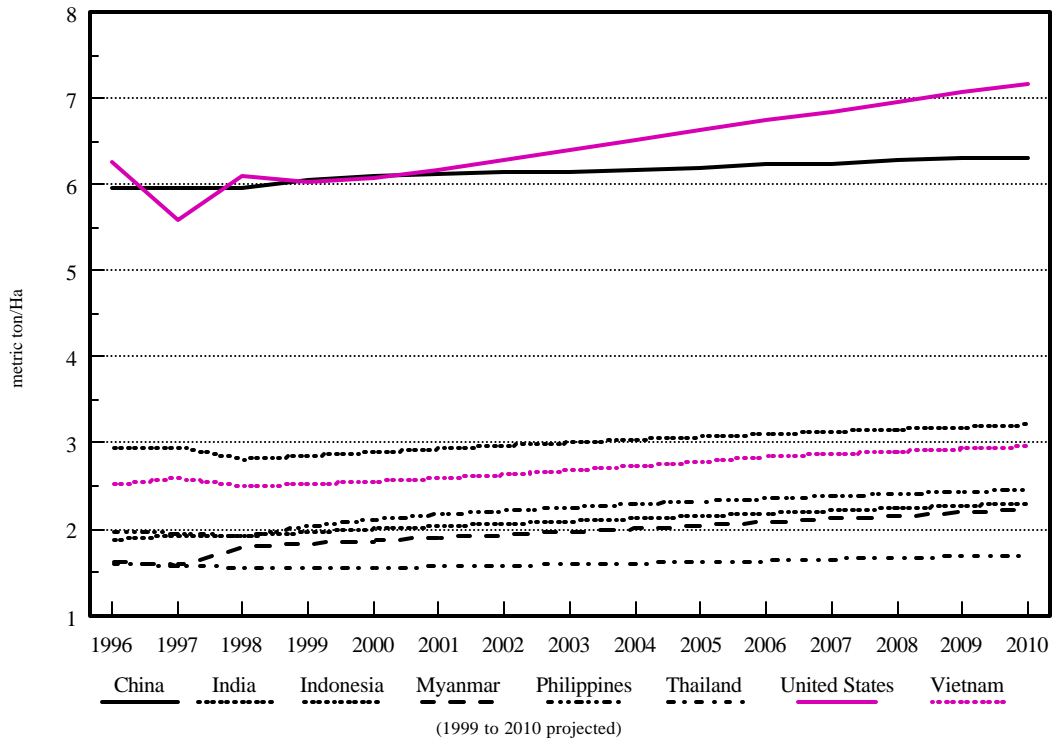


Figure 4. Indica Rice Yields in Major Producing and Consuming Countries, 1996-2010.

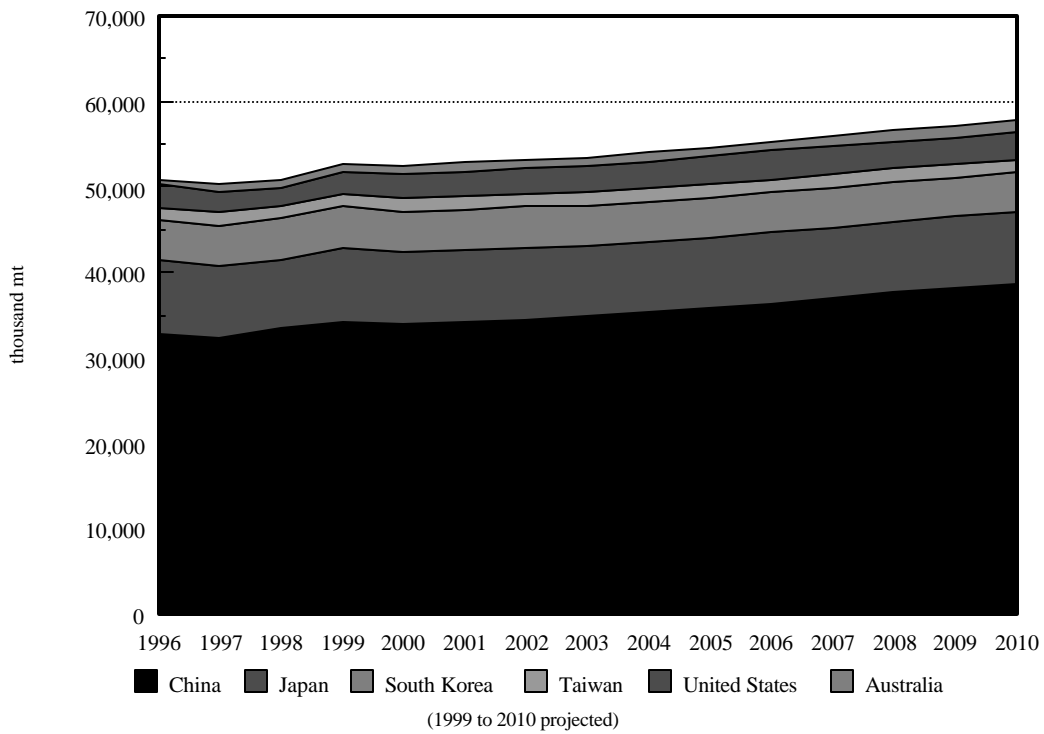


Figure 5. Japonica Rice Production in Major Producing and Consuming Countries, 1996-2010.

Yields for japonica rice in the United States were the highest in the world (7.8 metric tons/ha) in 1997 (Figure 6) and are projected to increase 10.7 percent through 2010. Yields in China are projected to increase 5.9 percent for the 1998-2010 period. Yields in Korea and Japan are projected to increase 6.7 percent and 7.1 percent for the same period.

### Rice Consumption

#### Indica Rice

Per capita consumption of indica rice ranges from 205.0 kg in Myanmar to 12.0 kg in the United States in the 1995-97 period (Table 3). Per capita consumption is projected to decrease in China, India, Indonesia, and the Philippines through 2010, while it is projected to increase in Vietnam, Thailand, Myanmar, and the United States (Figure 7).

Aggregate consumption of indica rice in China was 97 mmt annually in the 1995-97 period. The consumption is projected to increase 5.3 percent through 2010. India consumed 79.6 mmt per year during the 1995-97 period, and its consumption is projected to increase 23.0 percent through 2010. The increase in consumption is due mainly to expected increases in population during the same period. Aggregate consumption of indica rice in Indonesia and Vietnam also are projected to increase 17.7 percent and 24.6 percent, respectively, through 2010 (Figure 8).

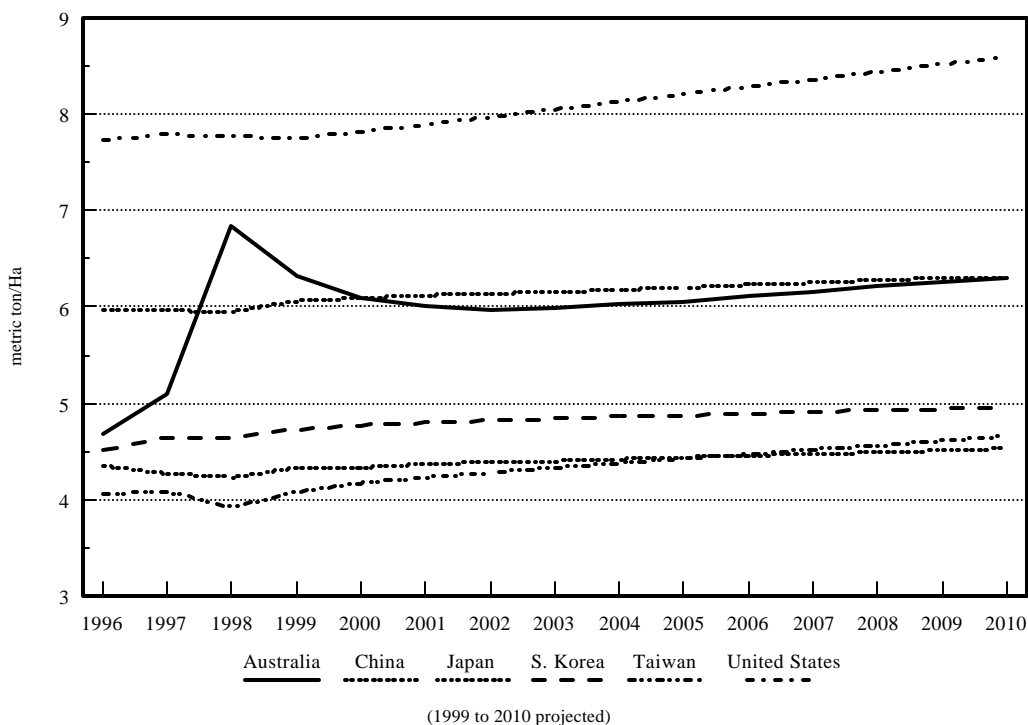


Figure 6. Japonica Rice Yields in Major Producing and Consuming Countries, 1996-2010.

**Table 3. Per Capita and Aggregate Consumption of Indica and Japonica Rice in Major Producing and Consuming Countries in the Base Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
<b>Indica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	78.45	78.95	77.41	75.99	-3.1
India	83.63	83.73	82.84	82.87	-0.9
Indonesia	172.40	165.70	167.04	167.73	-2.7
Vietnam	192.79	191.30	196.55	202.27	4.9
Thailand	143.05	146.40	154.51	153.93	7.6
Myanmar	204.98	199.10	202.52	205.51	0.3
Philippines	110.85	133.50	100.37	100.62	-9.2
United States	11.96	12.36	13.08	14.15	18.3
<u>Consumption</u> -----1,000 metric tons-----					
China	96,808	99,301	101,429	101,970	5.3
India	79,639	82,487	89,850	97,990	23.0
Indonesia	33,926	33,611	36,907	39,923	17.7
Vietnam	14,500	14,710	16,344	18,067	24.6
Thailand	8,600	9,000	10,015	10,425	21.2
Myanmar	9,344	9,280	10,081	10,924	16.9
Philippines	7,877	8,240	8,197	9,122	15.8
United States	3,181	3,349	3,723	4,223	32.7
<b>Japonica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	26.94	27.02	27.30	28.94	7.4
Japan	72.99	72.20	71.00	68.99	-5.6
S. Korea	111.69	110.30	107.50	100.90	-9.7
United States	6.59	6.66	6.81	7.23	9.7
Taiwan	65.59	59.42	66.14	61.32	-6.5
Australia	16.00	16.20	16.48	16.57	3.6
<u>Consumption</u> -----1,000 metric tons-----					
China	33,245	33,985	35,774	39,304	18.2
Japan	9,168	9,128	9,066	8,807	-3.9
S. Korea	5,062	5,099	5,256	5,152	1.8
United States	1,753	1,805	1,939	2,158	23.2
Taiwan	1,410	1,300	1,527	1,487	5.4
Australia	292	303	324	340	16.4

<sup>1</sup> Compared to the 1995-97 average.



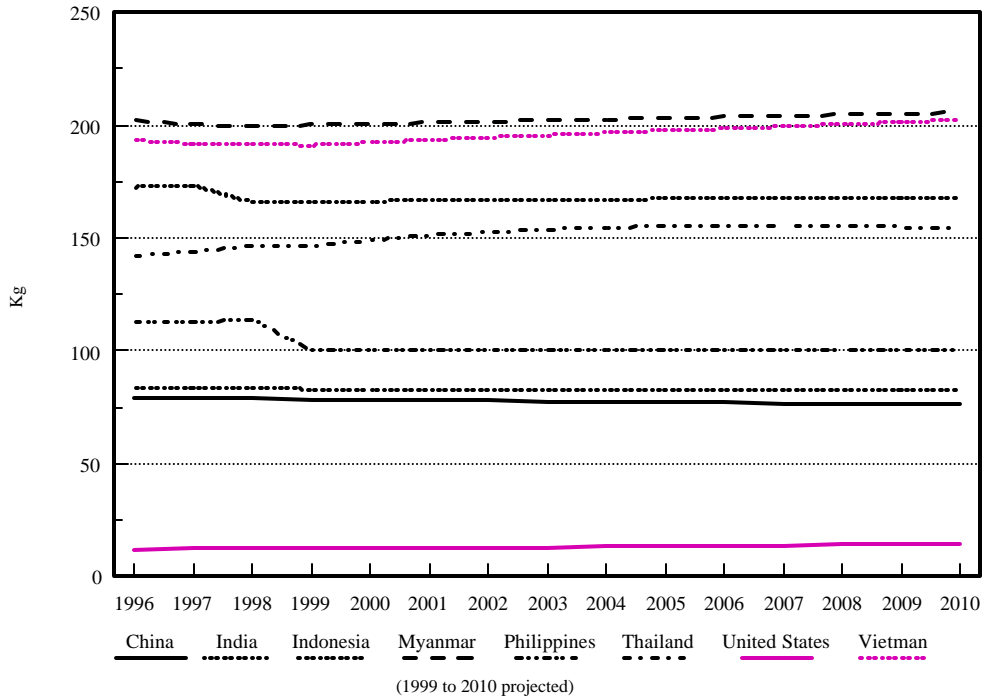


Figure 7. Per Capita Consumption of Indica Rice in Major Producing and Consuming Countries under the Base Scenario, 1996-2010.

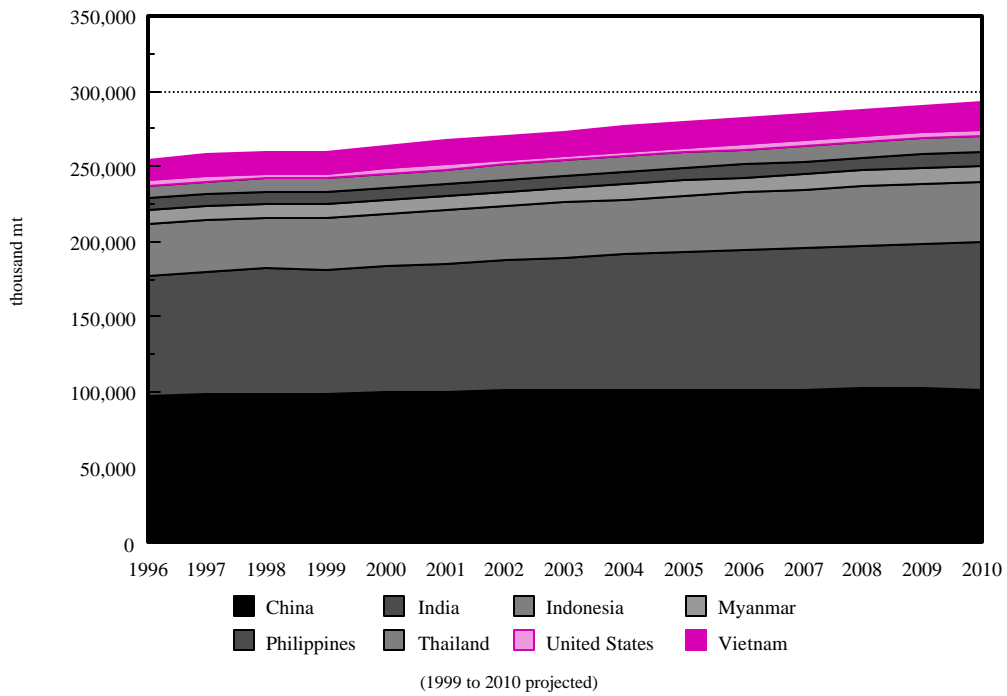


Figure 8. Aggregate Consumption of Indica Rice in Major Producing and Consuming Countries under the Base Scenario, 1996-2010.

## Japonica Rice

Per capita consumption of japonica rice was the largest in Korea (111.7 kg) in the 1995-97 period, followed by Japan (73.0 kg). However, per capita consumption is projected to decrease for the 1998-2010 period. In China, unlike per capita consumption of indica rice, consumption of japonica rice is expected to increase through 2010. This is mainly because Chinese people tend to prefer japonica rice to indica rice. Per capita consumption in the United States is also projected to increase through 2010 (Figure 9).

China consumed 33.2 mmt of japonica rice in the 1995-97 period, and consumption is projected to increase 18.2 percent through 2010. Aggregate consumption of japonica rice in Japan is projected to decrease 3.9 percent from 9.2 mmt per year in the 1995-97 period to 8.8 mmt in 2010. Consumption in Korea was 5.1 mmt per year in the 1995-97 period and is projected to increase 1.8 percent through 2010. Consumption in the United States is projected to increase 23.2 percent through 2010 (Figure 10).

## Rice Trade

Thailand is the largest exporter of indica rice, followed by Vietnam and the United States. Thailand exported 5.6 mmt in the 1995-97 period and its exports are projected to increase 34.0 percent by 2010 (Table 4). Vietnam and the United States exported 3.2 mmt and 2.4 mmt of indica rice, respectively, in the 1995-97 period. Their exports are projected to increase 57.2 percent and 95.3 percent, respectively, by 2010. India's exports of indica rice were 2.6 mmt and are projected to increase 22.9 percent by 2010.

Major importing countries of indica rice are China, Indonesia, and the Philippines. Indonesia was the largest importer, followed by China during the 1995-97 period. However, the quantities of indica rice imported by the countries are expected to change during the 1998-2010 period. China is predicted to decrease its imports, while Indonesia increases slightly.

The United States is the largest exporter of japonica rice, followed by Australia. U.S. exports of japonica rice were 0.82 mmt in the 1995-97 period and are projected to increase 28.8 percent by 2010. Australia exported 0.54 mmt in the 1995-97 period and is projected to increase 81.4 percent by 2010. China is projected to become an importer of japonica rice by 2010.

Japan was the largest importer of japonica rice in the 1995-97 period. Japan imported 0.41 mmt in the 1995-97 period and its imports are projected to increase by 2010. Its imports are expected to be 3.6 percent of domestic consumption in 2010. Korea is expected to increase its imports substantially during the 1998-2010 period. Its imports are expected to be 10 percent of domestic consumption in 2010.

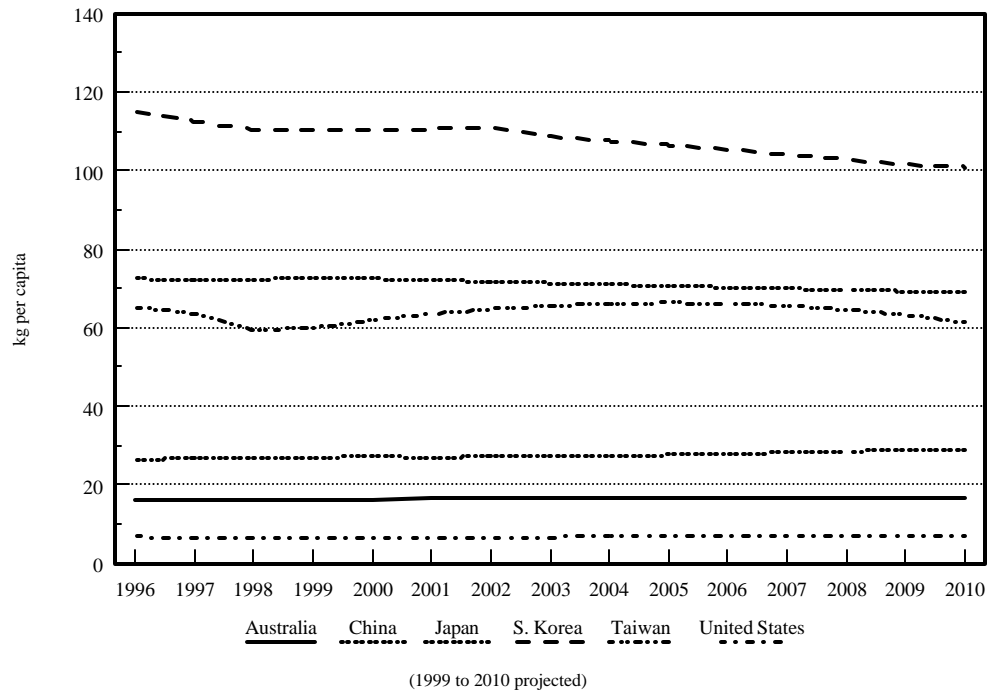


Figure 9. Per Capita Consumption of Japonica Rice in Major Producing and Consuming Countries under the Base Scenario, 1996-2010.

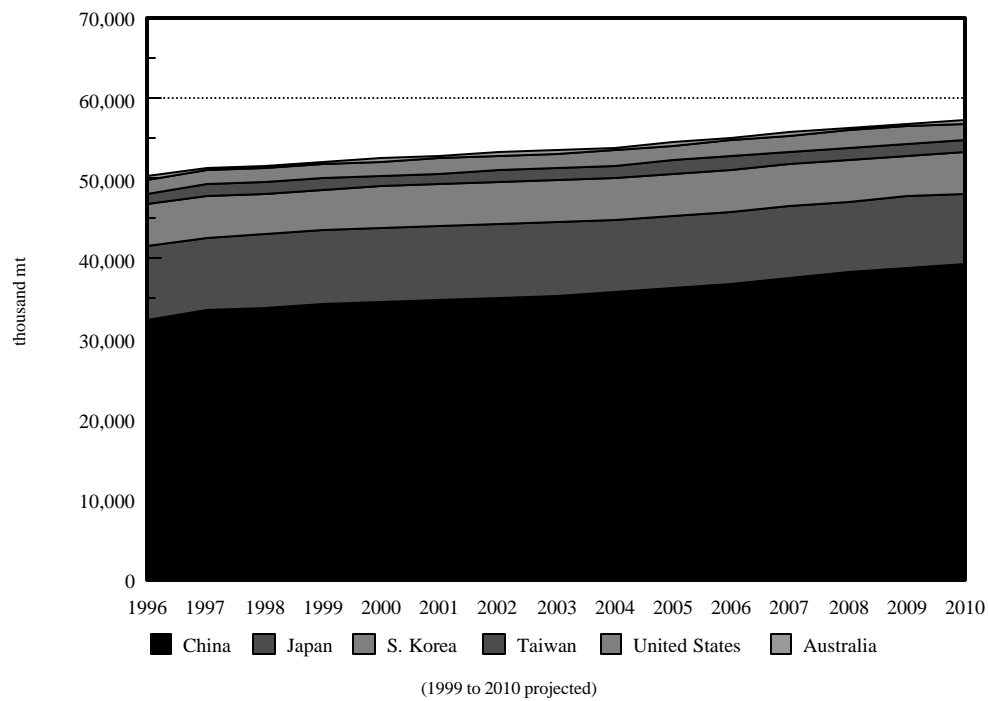


Figure 10. Aggregate Consumption of Japonica Rice in Major Producing and Consuming Countries under the Base Scenario, 1996-2010.

**Table 4. Trade of Indica and Japonica Rice in Major Producing and Consuming Countries in the Base Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	-433	-600	-623	-202	-53.4
India	2,573	2,500	2,499	3,155	22.6
Indonesia	-1,495	-2,300	-1,958	-1,655	8.5
Vietnam	3,234	3,500	4,341	5,085	57.2
Thailand	5,602	5,800	6,506	7,508	34.0
Myanmar	152	200	37	209	37.0
Philippines	-854	-1,000	-647	-832	-2.6
United States	2,434	3,585	4,307	4,754	95.3
<u>Japonica Rice</u>					
China	20	20	-531	-624	-----
Japan	-409	-800	-1,088	-1,409	244.2
S. Korea	-109	-130	-554	-515	374.1
United States	817	680	1,175	1,052	28.8
Taiwan	111	40	30	41	-62.8
Australia	537	650	695	974	81.4

<sup>1</sup> Compared to the 1995-97 average.

Numbers in parenthesis indicate imports.

### **Partial Import Liberalization Scenario**

This scenario is based on a partial liberalization of rice imports in Korea and Japan from the year completing their minimum market access commitments under the UR agreement to 2010 in Japan and 2014 in Korea, while other countries maintain their current trade policies on rice trade. The purpose of this scenario is to evaluate the impacts of a trade policy option, which is a partial import liberalization in Japan and Korea, on the world japonica and indica rice industry and also on the rice industry in these two countries. In the partial trade liberalization scenario, the ratios of domestic price to world price are reduced from 3.81 in 1997 to 1.50 in 2010 in Japan, and the ratios are reduced from 4.26 in 1997, to 2.52 in 2010, and to 1.50 in 2014 in Korea. Since Korea starts the trade liberalization process in 2004 (Japan in 2000), the process takes four more years to reach the ratio of 1.5 in Korea.

Under this scenario, the world price of japonica rice is expected to be higher than that under the base scenario for the 1998-2010 period, while the price of indica rice is similar to that under the base scenario (Figure 11). The price of japonica rice is expected to increase 13.8 percent from \$477/metric ton to \$542/metric ton in 2010. Increases in import demand for japonica rice in Korea and Japan under this scenario raise the world price of japonica rice for the period. The domestic price of japonica rice is expected to decrease 124 percent in Japan and 67 percent in Korea. The decreased domestic price of rice in these countries would reduce net farm income and may result in substantial adjustments in rice farm operation and size.

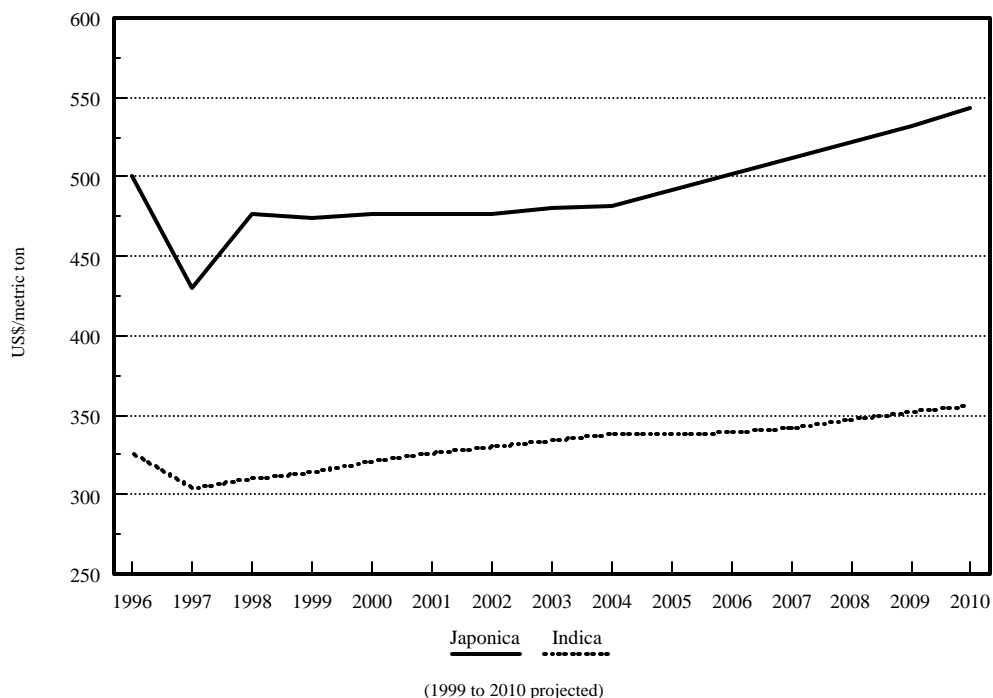


Figure 11. World Export Prices of Indica and Japonica Rice under the Partial Trade Liberalization Scenario, 1996-2010.

Japan and Korea are expected to reduce their japonica rice production under this scenario, compared to that under the base scenario. Japan is expected to decrease rice production from 8.3 mmt under the base scenario to 7.7 mmt under this scenario in 2010, and Korea also is expected to decrease its production from 4.7 mmt to 4.4 mmt (Table 5). The decreases in rice production are mainly because of the decreased domestic price of japonica rice in the countries under the import liberalization scenario. On the other hand, the United States and Australia are expected to increase their japonica rice production in this scenario, compared to those under the base scenario. U.S. production of japonica rice is projected to increase from 3.2 mmt in the base scenario to 3.5 mmt in this scenario in 2010, and Australia’s production increases from 1.3 mmt to 1.5 mmt.

The impacts of the import liberalization policy on the production of indica rice are much smaller than that on japonica rice production. The United States is expected to reduce production of indica rice to produce more japonica rice. The United States is expected to reduce indica rice production from 9.0 mmt in the base scenario to 8.9 mmt in the trade liberalization scenario in 2010. These decreases in indica rice production are mainly because of the higher price of japonica rice in the trade liberalization scenario. Other countries maintain their production of indica rice at the similar level under these two scenarios mainly because the countries have produced only indica rice and have very limited capability to switch to japonica rice production even though the price of japonica rice is higher than that of indica rice.

**Table 5. The Production of Indica and Japonica Rice in Major Producing and Consuming Countries in the Partial Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	94,645	94,628	101,164	103,875	9.8
India	81,283	81,292	90,341	98,180	20.8
Indonesia	33,172	32,634	35,166	38,298	15.5
Vietnam	17,846	18,378	20,360	22,536	26.3
Thailand	14,934	15,454	16,776	18,077	21.1
Myanmar	9,367	9,700	10,125	11,156	19.1
Philippines	7,438	6,088	7,631	8,325	11.9
United States	5,530	7,075	8,038	8,925	61.4
<u>Japonica Rice</u>					
China	33,058	33,385	34,698	36,861	11.5
Japan	8,904	8,048	8,524	7,713	-13.4
S. Korea	4,764	4,862	4,641	4,431	-7.5
United States	2,484	2,239	2,986	3,478	40.0
Taiwan	1,469	1,410	1,516	1,468	-0.1
Australia	831	888	1,091	1,487	79.0

<sup>1</sup> Compared to the 1995-97 average.

Per capita consumption in Korea and Japan is expected to be 103.6 kg and 66.77 kg, respectively, in 2010. Korea's consumption is larger than in the base scenario while Japan's consumption is smaller than those in the base scenario (Table 6). Import liberalization in these two countries tends to lower domestic price of japonica rice and raise per capita consumption through price effects. However, the income effect is large enough to offset the price effect in Japan. There are decreases in the consumption of japonica rice in other countries in this trade liberalization scenario, compared to the base scenario, but the changes are not significant. There are no significant changes in per capita consumption of indica rice in the countries in this trade liberalization scenario, compared to the base scenario.

Japan and Korea are expected to increase their imports through 2010 in this trade liberalization scenario. Japanese imports of japonica rice are expected to increase from 1.41 mmt in the base scenario (Table 4) to 1.8 mmt in the partial trade liberalization scenario in 2010, and Korean imports increase from 0.52 mmt to 0.86 mmt (Table 7). These imports are 20.6 percent of expected domestic consumption in Japan in 2010 and 16.2 percent in Korea. On the other hand, the United States and Australia are expected to increase their exports of japonica rice during the 1998-2010 period in the partial trade liberalization scenario, compared to the base scenario. Expected increases in exports of japonica rice in the United States are from 1.05 mmt in the base scenario to 1.3 mmt in the partial trade liberalization scenario and expected increases in imports in Australia are from .97 mmt to 1.5 mmt. There are no significant changes in exports of indica rice in the trade liberalization scenario, compared to the base scenario, except in China. China is expected to increase its exports of indica rice in this scenario, compared to the base scenario.

**Table 6. Per Capita and Aggregate Consumption of Indica and Japonica Rice in Major Producing and Consuming Countries in the Partial Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
<b>Indica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	78.45	78.95	77.81	78.79	0.3
India	83.63	83.73	82.84	82.87	-0.9
Indonesia	172.40	165.70	166.84	167.53	-2.8
Vietnam	192.79	191.30	196.45	201.31	4.4
Thailand	143.05	146.40	154.51	153.93	7.6
Myanmar	204.98	199.10	202.52	205.51	0.3
Philippines	110.85	133.50	100.27	100.52	-9.3
United States	11.96	12.36	13.08	14.13	18.0
<u>Consumption</u> -----1,000 metric tons-----					
China	96,808	99,301	101,974	105,565	9.0
India	79,639	82,487	87,837	95,980	20.5
Indonesia	33,926	33,611	36,839	39,871	17.5
Vietnam	14,500	14,710	16,244	17,976	24.0
Thailand	8,600	9,000	10,011	10,421	21.2
Myanmar	9,344	9,280	10,080	10,923	16.9
Philippines	7,877	8,240	8,188	9,115	15.7
United States	3,181	3,349	3,714	4,215	32.5
<b>Japonica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	26.94	27.02	27.60	27.22	1.0
Japan	72.99	72.20	68.80	66.77	-8.5
S. Korea	111.69	110.30	106.10	103.60	-7.2
United States	6.59	6.66	6.81	7.21	9.2
Taiwan	65.59	59.42	66.14	61.32	-6.5
Australia	16.00	16.20	16.39	16.53	2.3
<u>Consumption</u> -----1,000 metric tons-----					
China	33,245	33,985	35,851	36,964	11.2
Japan	9,168	9,128	8,786	8,535	-6.9
S. Korea	5,062	5,099	5,188	5,291	4.5
United States	1,753	1,805	1,935	2,149	22.6
Taiwan	1,410	1,300	1,527	1,487	5.4
Australia	292	303	323	336	14.9

<sup>1</sup> Compared to the 1995-97 average.

**Table 7. Trade of Indica and Japonica Rice in Major Producing and Consuming Countries in the Partial Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	-433	-600	-846	-1,727	299.3
India	2,573	2,500	2,428	2,120	-17.6
Indonesia	-1,495	-2,300	-1,632	-1,584	6.0
Vietnam	3,234	3,500	4,116	4,559	41.0
Thailand	5,602	5,800	6,738	7,652	36.6
Myanmar	152	200	34	203	33.3
Philippines	-854	-1,000	-597	-815	-4.6
United States	2,434	3,585	4,325	4,714	93.6
<u>Japonica Rice</u>					
China	20	20	-154	-105	-----
Japan	-409	-800	-1,261	-1,761	330.6
S. Korea	-109	-130	-538	-860	507.3
United States	817	680	1,031	1,300	59.2
Taiwan	111	40	-11	-51	-----
Australia	537	650	755	1,148	113.8

<sup>1</sup> Compared to the 1995-97 average.

Numbers in parenthesis indicate imports.

### Full Import Liberalization Scenario

This scenario is based on a complete liberalization of rice imports in Korea and Japan from the year completing their minimum market access commitments under the UR agreement to 2010, while other countries maintain their current trade policies on rice trade. The purpose of this scenario is to evaluate the impacts of an extreme trade policy option, which is a complete import liberalization in Japan and Korea, on the world japonica and indica rice industry and also on the rice industry in these two countries. In this full import liberalization scenario, the ratios of domestic price to world price are reduced 3.81 in 1997 to 1.2 in 2010 in Japan and 4.35 in 1997 to 1.95 in 2010 and 1.2 in 2014 in Korea.

Under this scenario, the world price of japonica rice is expected to be higher than that under the base scenario for the 1998-2010 period, while the price of indica rice is similar to those under the base scenario (Figure 11). The price of japonica rice is expected to increase 19.7 percent from \$477/metric ton to \$571/metric ton in 2010 (the price increase is 13.8 percent in the partial trade liberalization scenario). Increase in import demand for japonica rice in Korea and Japan under this scenario results in an increase in the world price of japonica rice for the period. The domestic price of rice will be reduced 147 percent in Japan and 72 percent in Korea. The decreased domestic price may affect net farm income and result in major adjustments in rice farm operation and size.



Japan and Korea are expected to reduce their japonica rice production substantially under this scenario, compared to that under the base scenario. Japan is expected to decrease rice production from 8.3 mmt under the base scenario to 6.5 mmt under this scenario in 2010, and Korea also is expected to decrease its production from 4.7 mmt to 4.1 mmt (Table 8). The decrease in rice production is mainly because of the decreased domestic price of japonica rice in the countries under this scenario. On the other hand, the United States and Australia are expected to increase their japonica rice production in this scenario, compared to under the base scenario. U.S. production of japonica rice is projected to increase from 3.2 mmt in the base scenario to 4.2 mmt in this scenario in 2010 and Australia's production is projected to increase from 1.3 mmt to 2.1 mmt.

**Table 8. The Production of Indica and Japonica Rice in Major Producing and Consuming Countries in the Full Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	94,645	94,628	101,149	103,633	9.5
India	81,283	81,292	90,346	98,184	20.8
Indonesia	33,172	32,634	35,166	38,298	15.5
Vietnam	17,846	18,378	20,359	22,536	26.3
Thailand	14,934	15,454	16,777	18,078	21.1
Myanmar	9,367	9,700	10,124	11,156	19.1
Philippines	7,438	6,088	7,632	8,325	11.9
United States	5,530	7,075	8,037	8,894	60.8
<u>Japonica Rice</u>					
China	33,058	33,385	34,718	37,045	12.1
Japan	8,904	8,048	7,740	6,514	-26.8
S. Korea	4,764	4,862	4,647	4,134	-13.2
United States	2,484	2,239	3,495	4,204	69.2
Taiwan	1,469	1,410	1,516	1,468	-0.1
Australia	831	888	1,481	2,144	158.1

<sup>1</sup> Compared to the 1995-97 average.

The impacts of the import liberalization policy on the production of indica rice are much smaller than that on japonica rice production. The United States is expected to reduce production of indica rice to produce more japonica rice. The United States is expected to reduce indica rice production from 9.0 mmt in the base scenario to 8.9 mmt in the full trade liberalization scenario in 2010. These decreases in indica rice production are mainly because of the higher price of japonica rice in the trade liberalization scenario. Other countries maintain their production of indica rice at a similar level under these two scenarios mainly because the countries produce only indica rice and have very limited capability to switch to japonica rice production even though the price of japonica rice is higher than that of indica rice.

Per capita consumption in Korea and Japan is expected to be 106.2 kg and 66.5 kg, respectively, in 2010, which is smaller than in the base scenario (Table 9). There are not significant changes in per capita consumption of indica rice in the countries in this trade liberalization scenario, compared to the base scenario.

**Table 9. Per Capita and Aggregate Consumption of Indica and Japonica Rice in Major Producing and Consuming Countries in the Full Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
<b>Indica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	78.45	78.95	77.81	78.79	0.3
India	83.63	83.73	82.84	82.87	-0.9
Indonesia	172.40	165.70	166.84	167.53	-2.9
Vietnam	192.79	191.30	196.45	201.17	4.3
Thailand	143.05	146.40	154.51	153.93	7.6
Myanmar	204.98	199.10	202.52	205.51	0.3
Philippines	110.85	133.50	100.27	100.52	-9.3
United States	11.96	12.36	13.08	14.13	18.0
<u>Consumption</u> -----1,000 metric tons-----					
China	96,808	99,301	101,974	105,565	9.0
India	79,639	82,487	87,838	95,979	20.5
Indonesia	33,926	33,611	36,843	39,864	17.5
Vietnam	14,500	14,710	16,250	17,964	23.9
Thailand	8,600	9,000	10,011	10,421	21.2
Myanmar	9,344	9,280	10,080	10,923	16.9
Philippines	7,877	8,240	8,189	9,115	15.7
United States	3,181	3,349	3,714	4,214	32.4
<b>Japonica Rice</b>					
<u>Per Capita Food Use</u> -----kilograms-----					
China	26.94	27.02	26.76	27.38	1.6
Japan	72.99	72.20	69.22	66.51	-7.5
S. Korea	111.69	110.30	108.10	106.20	-4.9
United States	6.59	6.66	6.85	7.25	9.9
Taiwan	65.59	59.42	66.74	61.81	-5.8
Australia	16.00	16.20	16.50	16.39	2.5
<u>Consumption</u> -----1,000 metric tons-----					
China	33,245	33,985	35,851	36,964	11.2
Japan	9,168	9,128	8,831	8,629	-5.9
S. Korea	5,062	5,099	5,241	5,387	6.4
United States	1,753	1,805	1,934	2,145	22.4
Taiwan	1,410	1,300	1,527	1,487	5.4
Australia	292	303	322	334	14.4

<sup>1</sup> Compared to the 1995-97 average.

Japan and Korea are expected to increase imports significantly through 2010 in this trade liberalization scenario. Japanese imports of japonica rice are expected to increase from 1.4 mmt in the base scenario to 2.1 mmt in the trade liberalization scenario in 2010 and Korean imports increase from 0.52 mmt to 1.2 mmt (Table 10). These rice imports account for 24 percent of expected rice consumption in Japan in 2010 and 22.9 percent in Korea. On the other hand, China, the United States, and Australia are expected to increase exports of japonica rice during the 1998-2010 period in the full trade liberalization scenario, compared to the base scenario. Expected increases in exports of japonica rice in the United States are from 1.1 mmt to 2.0 mmt, and expected increases in exports in Australia are from .97 mmt to 1.8 mmt. There are no significant changes in exports of indica rice in the trade liberalization scenario, compared to the base scenario, except in the United States. The United States is expected to decrease its exports of indica rice in this scenario, compared to the base scenario.

**Table 10. Trade of Indica and Japonica Rice in Major Producing and Consuming Countries in the Full Trade Liberalization Scenario**

Country	1995-97	1998	2004	2010	% Change <sup>1</sup>
-----1,000 metric tons-----					
<u>Indica Rice</u>					
China	-433	-600	-832	-1,969	355.3
India	2,573	2,500	2,433	2,125	-17.4
Indonesia	-1,495	-2,300	-1,637	-1,577	5.4
Vietnam	3,234	3,500	4,109	4,572	41.3
Thailand	5,602	5,800	6,741	7,653	36.6
Myanmar	152	200	33	203	33.1
Philippines	-854	-1,000	-597	-814	-4.7
United States	2,434	3,585	4,323	4,684	92.4
<u>Japonica Rice</u>					
China	20	20	-134	80	300.0
Japan	-409	-850	-1,088	-2,104	414.0
S. Korea	-109	-130	-536	-1,235	1,036.1
United States	817	680	1,503	2,022	147.6
Taiwan	111	40	-11	-15	-----
Australia	537	650	1,146	1,807	236.4

<sup>1</sup> Compared to the 1995-97 average.

#### 4. Concluding Remarks

Consumption for both japonica and indica rice is expected to be larger than the production of rice, resulting in general increases in the price of rice. However, the price of indica rice is predicted to increase faster than that of japonica rice.

China is expected to be the largest producer of indica rice for the next 10 years, followed by India. Indonesia is expected to be the third largest producer of indica rice. Production of indica rice is expected to increase. Thailand is expected to be the largest exporter of indica rice, followed by Vietnam and the United States. Major importing countries are China, the Philippines, and Indonesia.

China has been the largest producer of japonica rice, followed by Japan. China, the United States, and Australia are expected to increase production of japonica rice, while Japan and Korea are expected to decrease production. Consumption of japonica rice is expected to increase in the United States and China, while decrease in Japan. Korea may have a small increase in consumption. The United States is expected to be the largest exporter of japonica rice, followed by Australia. Japan is expected to import about 15.9 percent of domestic consumption and Korea is expected to import 10 percent.

The effects of the trade liberalization in Japan and Korea on the world japonica rice industry are expected to be significant, but its impacts on the world indica rice industry could be insignificant. The world price of japonica rice is expected to increase about 13.8 percent under the partial trade liberalization scenario and is expected to increase 19.7 percent under the full trade liberalization scenario. The domestic price of rice in Japan and Korea is expected to be reduced 124 percent and 57 percent, respectively, in the partial import liberalization scenario and 147 percent in Japan and 72 percent in Korea in the full trade liberalization scenario. The decreased domestic price would result in major reductions in net farm income in these countries, and may result in substantial adjustments in rice farm operation and size. Japan and Korea are predicted to decrease their rice production under the trade liberalization scenarios and increase imports of japonica rice. Japan is expected to import about 20.6 percent of expected domestic consumption in 2010 and Korea about 12.5 percent in the partial trade liberalization scenario. These two countries are expected to import substantially more in the full trade liberalization scenario. Japan's imports would be 24.3 percent of its domestic consumption under this scenario and Korea's imports would be about 22.9 percent of its domestic consumption.

## References

- Austrian Bureau of Agricultural and Resource Economics, Commodity Statistical Bulletin. Canberra, Australia, Various issues.
- Benirschka, Martin, and Won W. Koo. *World Wheat Policy Simulation Model: Description and Computer Program Documentation*. Agricultural Economics Report No.340, Department of Agricultural Economics, North Dakota State University, Fargo. 1995.
- Benirschka, Martin, Won W. Koo, and J. Lou. *World Sugar Policy Simulation Model: Description and Computer Program Documentation*. Agricultural Economics Report No.356, Department of Agricultural Economics, North Dakota State University, Fargo. 1996.
- Commission of the European Communities. Agricultural Markets. Brussels, Various issues.
- Eurostat. Agriculture: Statistical Yearbook. Luxembourg, Various issues.
- Food and Agricultural Policy Research Institute, FAPRI. *1998 U.S. Agricultural Outlook*. Iowa State University and University of Missouri. 1998.
- Food and Agricultural Policy Research Institute, FAPRI. *1998 World Agricultural Outlook*. Iowa State University and University of Missouri. 1998.
- International Monetary Fund. International Financial Statistics CD-Rom. Washington, DC. 1997.
- Park, Jin Hwan. *Rice Production in China: Special Reference to Japonica Rice*. Research Report No. 85, Agricultural Cooperative Development Institute, Seoul. 1993.
- U.S. Department of Agriculture, Economic Research Service. *Rice Situation and Outlook*. Washington, DC, Various issues.
- U.S. Department of Agriculture, Economic Research Service. *PS&D View* (Computer files).
- Wailles, Eric J., Gail Cramer, Eddie C. Chavez, and James Hansen. *Arkansas Global Rice Model: International Baseline Projections for 1998-2010*. Special Report 189, Arkansas Agricultural Experiment Station, University of Arkansas, Fayetteville. 1998.