Sharp decline in the food self-sufficiency ratio in Japan and it's future prospects

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1. Introduction

Most Japanese are enjoying rich and convenient dietary habits these days, and we are said to be living in an age of overabundance. There are increasingly growing concerns over excess or insufficient nutritional intake, such as the excessive intake of fat or unbalanced diets. At the same time the majority of Japanese are also concerned about food security. According to the result of "The Special Public Opinion Poll about Food Supply" carried out by the Cabinet Office in 2006, 76.7% of the respondents answered that they feel uncertain about food supply in the future[1]. The major reasons that many people are feeling anxiety about the future food supply are, first, the food self-sufficiency ratio has declined continuously for more than 45 years to 39% in 2006, which was the lowest among countries with a population of more than 100 million. Second, the level of domestic agricultural production has been decreasing since 1985. It has not recovered, despite continuous policy efforts at enhancing agricultural production. Third, the international prices of corn, soybeans, and wheat have started to increase sharply since the end of 2006, reflecting the sharp increase in demand due to the population explosion in LDC, the rapid economic growth of BRICs, as well as the expansion of bio-ethanol production.

In this paper, I have examined the causes and mechanisms of the decline in the food self-sufficiency ratio over the last 45 years, and have carried out a preliminary examination regarding factors that will influence the level of the future self-sufficiency ratio for food. I have also critically reviewed the Basic Plan for Food, Agriculture and Rural Areas, which set up the goal for raising the food self-sufficiency ratio to 45% by 2010.

2. Trends of the food self-sufficiency ratio

The food self-sufficiency ratio on a calorie basis is an index that shows the ratio of calorie supply from domestically produced food compared to the total calorie supply from food in the country. It is defined as follows.

$$\text{Food self-sufficiency ratio on a calorie basis} = (\text{per capita daily calorie supply from}$$
$$\text{domestically produced food} \div \text{per capita daily calorie supply from food}) \times 100$$

Japan's food self-sufficiency ratio on a calorie basis has decreased sharply, from 79% in 1960 to 40% in 2005. It did not fall at a constant rate; rather there were periods of rapid decline and periods of slow decline over the last 45 years, as shown in Figure 1. Therefore, analysis was carried out by dividing the last 45 years into four periods.

Fig. 1 Trends of Food Self-Sufficiecy Ratio and Per Capita Daily Calorie Supply
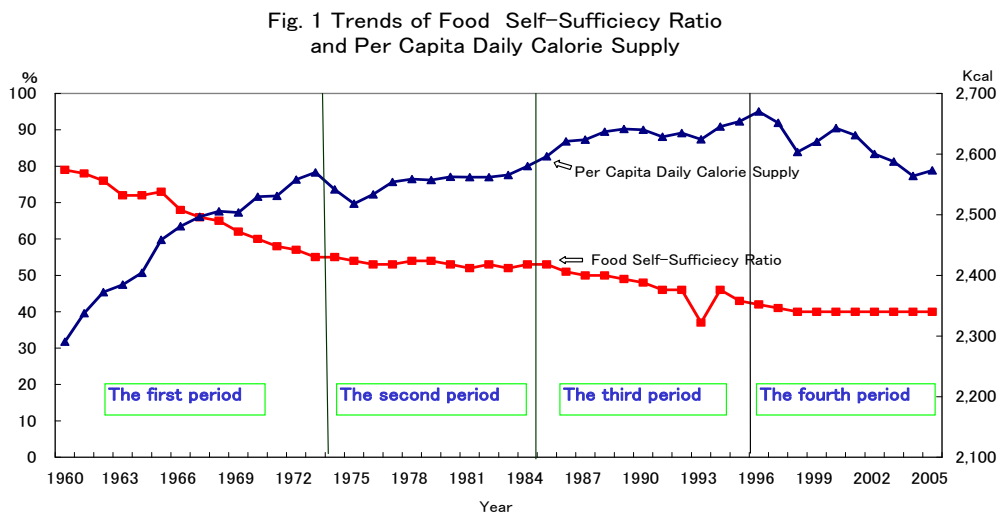
Source: Japan MAFF "Food Balance Sheet," various issues

The first period (1960-1973) : This period corresponds to the period of rapid economic growth where per capita daily calorie supply increased rapidly, at 21.5kcal per year. Big changes in dietary habits, which have been characterized as westernization, also took place in this period. The food self-sufficiency ratio declined at an annual average rate of 1.8 % points over the 13 years, from 79% in 1960 to 55% in 1973 (Table 1). Per capita daily calorie supply from the domestic agricultural sector, which is the numerator of the definition formula of the food self-sufficiency ratio, was rather stable between 1960 and 1965, but it has started to decline sharply since 1966 as shown in Fig. 5. This is due to a reduction in the production of wheat, oats, and soybeans. Rice production has also started to decrease since the end of the 1960s due to the introduction of the rice diversion

program.

Table 1　Food self-sufficiency ratio and per capita daily calorie supply

	First Period (1960—1973)	Second Period (1974—1984)	Third Period (1985—1995)	Fourth Period (1996–2005)
Food self-sufficiency ratio (%)	79 → 55	55 → 53	53 → 43	42 → 40
Annual average change (%)	−1.8	−0.2	−1.0	−0.2
Per capita daily calorie supply (kcal)	2,291 → 2,570	2,542 → 2,580	2,597 → 2,654	2,670 → 2,573
Annual average change (kcal)	21.5	3.8	5.7	−10.7
Rice (kcal)	1106 → 885	875 → 734	727 → 660	656 → 599
Annual average change (kcal)	−17.0	−14.1	−6.7	−6.3
Livestock products (kcal)	90 → 253	250 → 333	318 → 400	402 → 396
Annual average change (kcal)	12.5	8.3	8.2	−0.7
Oils and fats (kcal)	105 → 258	275 → 351	354 → 368	375 → 368
Annual average change (kcal)	11.8	7.6	1.4	−0.8

Source: Ministry of Agriculture, Forestry and Fisheries of Japan, "Food Balance Sheet", various issues

The denominator for the definition formula of the food self-sufficiency ratio increased rapidly, due to the sharp increase in the import of wheat, pulses, and millets, causing the food self-sufficiency ratio to decline overall.

The major causes of the decline in the food self-sufficiency ratio were the sharp decrease in rice consumption and a considerable increase in the consumption of livestock products, oils and fats, which are mostly produced from imported feed and oil seed crops. Per capita calorie supply from rice, the staple food of the Japanese, started to decline from 1962, and it decreased 220.3 kcal during the first period.

Regression analysis was carried out in order to examine the quantitative relationships between the food self-sufficiency ratio and the sharp decline in rice consumption, and the increase in the consumption of livestock products, oils and fats. The following regression result was estimated by using the time series data of 1960-73. Estimation result is considerably good. Coefficient of determination adjusted for degrees of freedom was high 0.986, and signs of estimated parameters are as we expected.

$$FSSR \ = \ 71.974 \ + \ 0.0175\,C_r \ - \ 0.062\,C_f$$

(5.667)　　(1.869)　　(-6.981)

$R^2 = 0.986$

Where,
　　　　FSSR: food self-sufficiency ratio
　　　　C_r: calorie supply from rice
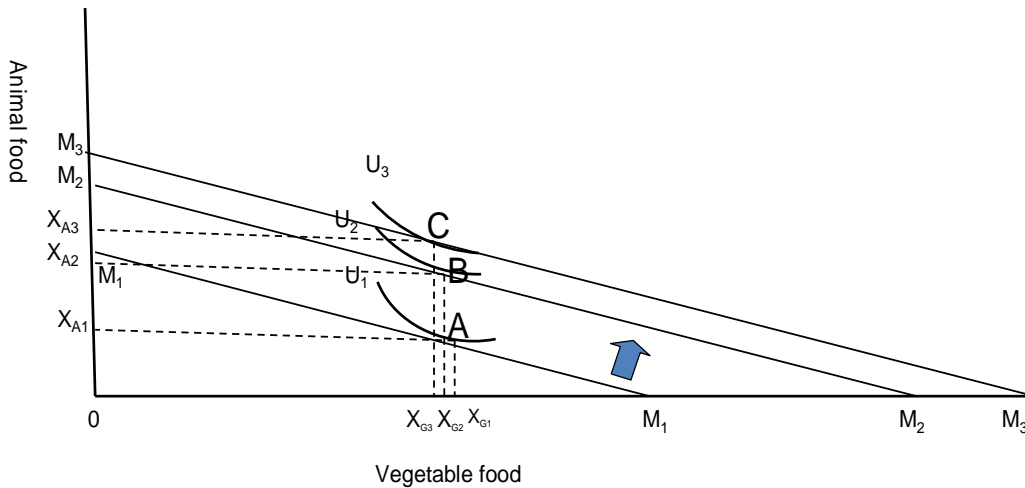　　　　C_f: calorie supply from livestock products, oils and fats

Fig. 2 Income increase and changes in food demand

The characteristics of the change in the dietary patterns can be shown by using the budget lines and indifference curves, as in Figure 2. The vertical axis shows animal foods on a calorie basis and the horizontal axis shows vegetable foods on a calorie basis. M_1M_1 is the budget line, and u_1 is the indifference curve. Point A indicates the utility maximization point under a given budget. Consumers purchase OX_{G1} of vegetable foods and OX_{A1} of animal foods. As personal income increases due to rapid economic growth, the budget line shifts to M_2M_2. Point B indicates the new utility maximization point at which a new indifference curve makes contact with a new budget line. Consumers purchase OX_{G2} of vegetable foods and OX_{A2} of animal foods, and therefore get a greater utility U_2. When compared with the initial equilibrium point A and the new equilibrium point B, calorie supply from animal foods increased by about 90 % and calorie supply from vegetable foods decreases slightly. In response to the increase in demand for animal foods, the

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livestock industry started to grow by increasing its dependence on imported animal feed. Maize and soybeans were mostly imported from the US because domestic production costs of these products are much higher due to the unfavorable farmland conditions in Japan, compared with that of the countries with abundant farmland like the US. The Japanese Government charged low tariff rates on imported animal feeds with the intention of developing the livestock industry by using cheaply imported animal feed. This policy contributed to the increase in feed imports. For the same reason oils and fats were also produced by using cheaply imported oilseeds.

Per capita annual average calorie supply from livestock increased by 12.5 kcal, and that from oils and fats increased by 11.8 kcal in this period. On the other hand the calorie supply from rice, which became an inferior good in the early 1960, declined by 17.0 kcal.

The second period (1974-84): The Japanese economy shifted to a low and steady growth after the First Oil Crisis of 1973, and the growth rate of income also slowed down. The food self-sufficiency ratio was confined to slight decline, from 55% in 1974 to 53% in 1984. The maturity of dietary habits started in this period, and a new trend of food consumption patterns, which was characterized as sophistication and diversification, began. Per capita annual food energy supply increased by 3.8kcal, which is considerably lower compared with that of the first period, 21.5 kcal. The changing pattern of food consumption was the same as the first period, but both the extent of the increase of calorie supply from livestock products, oils and fats, and the extent of the decrease in calorie supply from rice, was less than that of the first period.

These changes in the second period can be explained by Figure 2, as follows. Since the growth rate of income slowed down, the shift of the budget line M_2M_2 toward upper right is smaller, and a new equilibrium point is reached at C. The increase in calorie supply from animal foods is smaller than that of the first period. This resulted in a slow down of the growth rate of grain and soybeans imports, which are used for the production of livestock products and oils and fats. Therefore, the rate of decline of the food self-sufficiency ratio in the second period slowed down.

The third period (1985-1995): The Japanese yen appreciated drastically after the Plaza Agreement, from 235 yen per US dollar in 1985 to 94 yen per US dollar in 1995. Price index of imported agricultural products declined by 44% during the same period, and imports of livestock products, fish, shellfish, and fruits increased due to the sharp decline in prices of these agricultural products.

The average daily per capita calorie supply increased by 5.7kcal in this period. The average daily per capita calorie supply from rice declined by 6.7kcal, while calorie supply from livestock products, oils and fats increased by 8.2kcal. The food self-sufficiency ratio fell drastically by 10 % points, from 53% in 1985 to 43% in 1995, due to the substitution of domestic agricultural products with imported agricultural products.
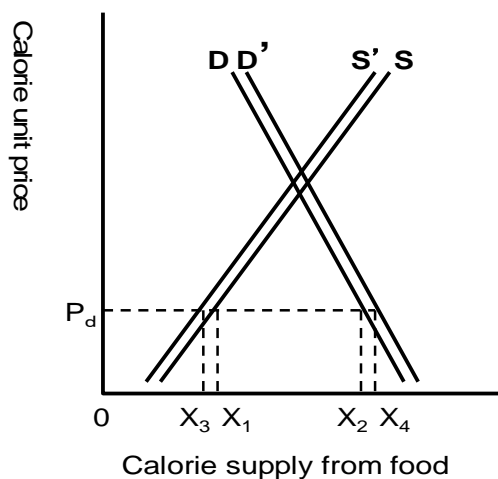
Domestic food market

Fig. 3 Calorie unit price of food and the
food self-sufficiency ratio

The decline of the food self-sufficiency ratio in this period can be shown as in Figure 3. This figure shows domestic agricultural markets, and the vertical axis shows calorie unit price, which is calculated by dividing expenditures on food by calorie supply, and the horizontal axis shows calorie

supply from food. Calorie unit price is P_d at the starting point of the third period, and it did not change much during the third period. The calorie supply from domestically produced agricultural products is OX_1, and calorie supply from imported agricultural products is X_1X_2. The food self-sufficiency ratio is expressed as $(OX_1/OX_2) \times 100$.

The demand curve shifted toward the right hand side, from D to D' due to the income growth, and the supply curve of domestically produced food shifted toward the left hand side, from S to S' during the third period. Calorie supply from domestically produced food declined from OX_1 to OX_3, and calorie supply from imported agricultural products increased from X_1X_2 to X_3X_4. The food self-sufficiency ratio thus declined from $(OX_1/OX_2) \times 100$ to $(OX_3/OX_4) \times 100$.

The fourth period (1996-2005): The economic bubble burst in the early 1990's and the Japanese economy collapsed in this period. Both of total calorie supply from food and calorie supply from domestically produced food decreased in this period. The rate of increase of food imports decelerated due to the loss of the high yen effect. The food self-sufficiency ratio fell gradually, by 2% points over 9 years, from 42% in 1996 to 40% in 2005.
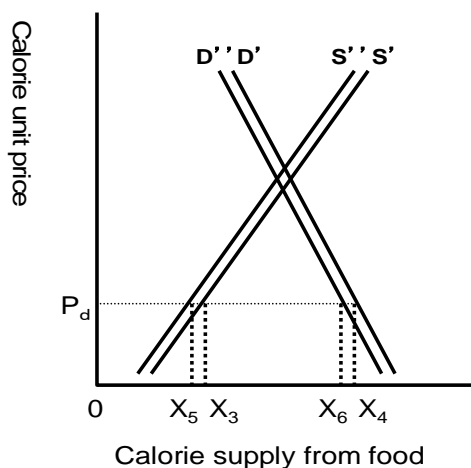

Fig. 4 Calorie unit price of food and the
food self-sufficiency ratio

This decline of the food self-sufficiency ratio due to the economic depression and the loss of the high yen effect can be shown as in Figure 4.   The calorie unit price was stable around P_d, and the demand curve shifted toward the left hand side, from D' to D" due to the economic recession, and the supply curve of domestically produced food also shifted toward the left hand side, from S' to S". Calorie supply from domestically produced food declined from OX_3 to OX_5, and calorie supply from imported agricultural products increased slightly from X_3X_4 to X_5X_6. The food self-sufficiency ratio thus declined from $(OX_3/OX_4) \times 100$ to $(OX_5/OX_6) \times 100$.

3.   Economic Development and trends of the food self-sufficiency ratio

In reality many more factors are affecting the level of the food self-sufficiency ratio. Hence, more comprehensive analysis will be carried out in this section.

(1) Domestic agricultural production

The Japanese agricultural and fishery production index had increased in the first and second period (1960-84), and it reached a peak in 1985. However, the agricultural production index began to decline since 1986 and it had shrunk about 20% by 2005. The decline in agricultural production is strongly associated with the reduction in rice production. Rice production was reduced by the introduction of the rice diversion program, which was started in the early 1970's, and has accelerated since the early 1980's, and continues until now. About 40% of paddy fields have been removed from rice production these days.

Another reason for the decline in agricultural production is that a major portion of agricultural products are produced as fresh food, and the Japanese agricultural sector cannot sufficiently satisfy the increased demand for foodstuffs from the food service industry and home-meal replacement industry. This resulted in the increased use of imported food in the food service industry and home-meal replacement industry. The percentage of imported agricultural products used in the food processing and the food service industry is generally increasing.

The livestock products produced by using imported feed, which are generally regarded as domestic products, are not included as domestic calories for the purpose of the calculation of the food self-sufficiency ratio on a calorie basis. Therefore, the self-sufficiency ratio of livestock products has been declining due to the decline in the livestock feed self-sufficiency ratio.

(2) Food consumption

The changes of the dietary patterns in Japan over the last 45 years are exceptionally dramatic by the world standards[2]. The style of food expenditures has also changed dramatically, as reflected by the substitution of home-made dishes for home meals with pre-prepared foods and eating-out results from an increase of single-member households and diversified lifestyles. In 2000, pre-prepared foods and eating-out comprised 27% of total food expenditures.

The decrease in the cost effectiveness of home cooking, due to the decrease in the number of household members and the increased enjoyment of gourmet food, has promoted an externalization of diet. Since the percentage of imported agricultural products used in food processing and the food service industry is high and increasing, the increasing externalization of diet also reduces the food self-sufficiency ratio.

(3) Household structure

The number of general households has increased while, at the same time, the proportion of single households (household with a single member) among the general households has increased considerably. As a result, the mean size of households has been decreasing. In a single household, eating out and the consumption of pre-prepared food accounted for 50% of living costs, while the percentage of eating out increases in the higher income group.

Women's participation in society has promoted gender equality in employment and the number of double-income households has increased. The time availability of women for home cooking has decreased, and has resulted in the reduction of cooking hours at home. This has increased eating out

and consumption of pre-prepared food, and this in turn contributed to reduce the food self-sufficiency ratio.

(4) Food trade liberalization and food imports

Japan has started to liberalize trade through bi-lateral and multi-lateral negotiations since around 1960[3]. The imports of 121 items of agricultural, forestry, and fishery products were liberalized in 1960. Banana trade was liberalized in 1963, and in the next year lemon imports were also liberalized. The import quotas of beef and oranges were expanded in 1984, and trade of these agricultural products was liberalized in 1991. 24 agricultural items were liberalized by GATT Uruguay Round agreement of 1993. The trade of rice shifted to a tariffication measure in 1999. In this way agricultural trade liberalization has been pushed forward rapidly during the past 40 years, and Japanese agriculture has been exposed to international competition.

Fig. 5 Trends of daily per capita calorie supply
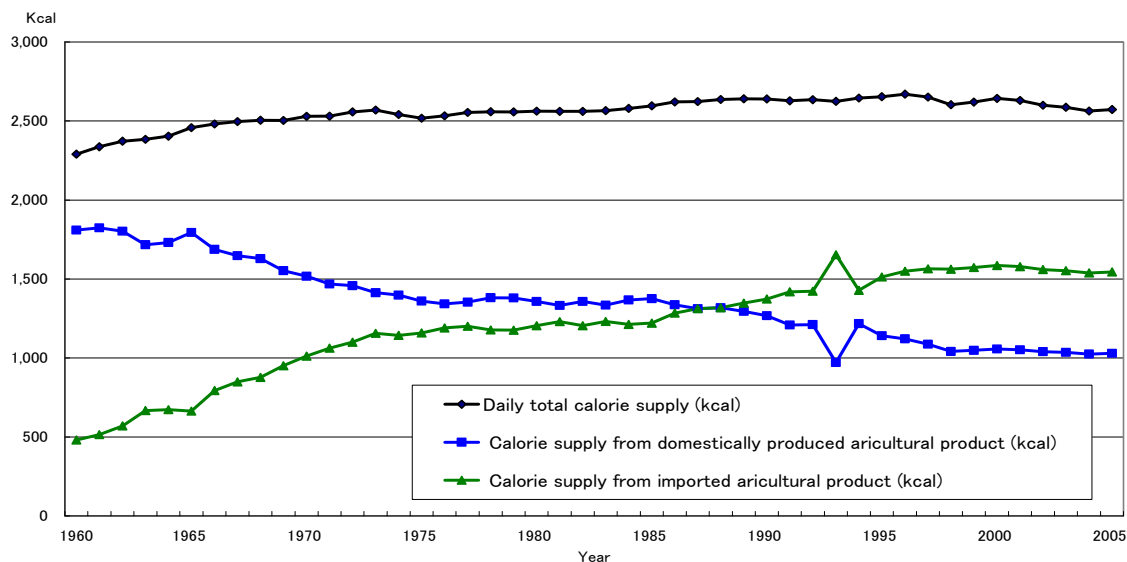
Source: Japan MAFF,"Food Balance Sheet,"various issues

Tariff rates for agricultural products have been reduced greatly, and the average tariff rate of agricultural products is 12%, which is not very high among developed countries. Agricultural

imports have increased at high rates since the 1960's, and Japan became the world largest net importer of agricultural products in 1984. Japan's position as the world largest net importer of agricultural products continues until now.

Fig. 5 shows trends of per capita daily calorie supply from imported food. Per capita daily calorie supply from imported food surpassed that of calorie supply from domestically produced food in 1989, and thereafter the difference between the two has been increasing.

4.   Recent policies for improving the food self-sufficiency ratio

According to the result of "The Public Opinion Poll about the Role of Food, Agriculture, and Rural Areas" carried out by the Cabinet Office in 2008, 79.2% of respondents replied that Japan's self-sufficiency ratio of 40% for food supply is too low. Public opinion polls carried out by the Government in the 1990's also showed similar results. Taking these public opinions into consideration the Japanese government decided to increase the food self-sufficiency ratio. The Basic Law on Food, Agriculture, and Rural Areas enacted in 1999, stated that a target for the food self-sufficiency ratio should be established in view of improving this ratio. The Basic Plan on Food, Agriculture and Rural Areas（hereinafter referred to as the Basic Plan）, enacted in 2000, indicated a desirable food consumption form that provides the outlook for the next 10 years, as well as targets for efforts to be made in agricultural production, and the prospects for agricultural management and structure. The Basic Plan set up a target for the food self-sufficiency ratio to be achieved by 2010, at 45% on a calorie basis. This target for the food self-sufficiency ratio was expected to be achieved based on the efforts of related parties including producers, consumers, and food industries.

However, the overall food self-sufficiency ratio remained unchanged at 40% between 1999 and 2005. On the basis of the failure in achieving the target for the food self-sufficiency ratio the New Basic Plan was enacted in 2005, and set up a new target for raising the food self-sufficiency ratio to 45% by 2015. The Food Self-Sufficiency Ratio Improvement Council was established in 2005, and formulated the action plans to steadily improve the food self-sufficiency ratio[4].

5.　Projections of the food self-sufficiency ratio and domestic calorie supply in 2015

In this section some preliminary projections of the food self-sufficiency ratio and domestic calorie supply in 2015 will be carried out.

(1)　Projection of the food self-sufficiency ratio in 2015

The food self-sufficiency ratio in 2015 is projected based on the projected future population [5] and the following three assumptions concerning the per capita daily calorie supply and the per capita calorie supply from domestically produced food. It is assumed that the calorie supply from domestically produced food would follow the trend of the period 1996 - 2006 for three cases. In case A, the food self-sufficiency ratio in 2015 is projected based on the assumption that per capita daily calorie supply would stay at the 2006 level, i.e. 2,548Kcal. In case B, it is assumed that per capita daily calorie supply would be 2,480Kcal in 2015, which is the estimate described in the New Basic Plan for Food, Agriculture, and Rural Areas.[6] In case C, per capita daily calorie supply is assumed to follow the trend of 1996-2006.

Then, the food self-sufficiency ratio is projected to decline gradually to 37% by 2015 in case A and 38% in case B. In case C the food self-sufficiency ratio is projected to stay at 39% during the period 2006-2015.

These projection results imply that if the calorie supply from domestically produced food follows the trend from 1996 to 2006 the food self-sufficiency ratio in 2015 is projected either to stay at 39% or decline slightly during the period 2005-2015. These projection results imply that calorie supply from domestically produced food has to be increased considerably in order to raise the food self-sufficiency ratio to 45% by 2015.

(2)　Projections of domestic calorie supply

The new Basic Plan of 2005 set up a target for raising the food self-sufficiency ratio to 45% by 2015. In this section three projections will be carried out concerning the level of the domestic alorie

supply that is necessary to attain this target. In case 1, the level of domestic calorie supply is calculated based on the assumption that per capita daily calorie supply would stay at the 2006's level, i.e. 2,548Kcal. In case 2, per capita daily calorie supply is assumed to be 2,480kcal, and in case 3 per capita daily calorie supply is assumed to follow the trend of 1996-2006.

In case 1, the level of total domestic calorie supply that is necessary to attain the 45% self-sufficiency ratio would be 143.8 billion Kcal per day in 2015. This daily calorie supply from domestically produced food is close to the level of 1995. In case 2, the daily calorie supply from domestically produced food would be 140.0 billion Kcal per day in 2015. This is close to the level of 1996. In case 3, the level of daily calorie supply from domestically produced food would be 138.7 billion Kcal per day in 2015. This is also close to the level of 1996. These calculation results mean that daily total domestic calorie supply from food in 2015 should be similar to the level of the time when enforcement of the agricultural agreement of GATT Uruguay Round started. Total planted areas in 1996 were 4.8million ha, about 10% larger than that of 2005. These projection results imply that in order to achieve the policy goal of raising the food self-sufficiency ratio to 45% by 2015, the daily calorie supply from domestically produced food in 2015 should be similar to the level of the middle of the 1990's. This means that policy effort of expanding total planted areas by about 10% is required for attaining the goal of raising the food self-sufficiency ratio to 45% by 2015[7].

7. Conclusion

Japan's food self-sufficiency ratio was 79% in 1960, and this ratio compares favorably with that of other advanced countries with similar farmland endowments. But Japan's food self-sufficiency ratio fell most rapidly of all major developed countries in the last 45 years, and it became the lowest among countries with more than 100 million in population. Epoch making events such as drastic change of dietary habits under a rapid economic growth and drastic appreciation of the yen against the US dollar were related to the sharp fall of the food self-sufficiency ratio.

Judging from past experience, epoch making efforts or events will be needed to achieve the target of improving the food self-sufficiency ratio to 45% by 2015. More discussion concerning the effectiveness of policy measures such as food education, people's social campaigns, enlightenment, institutional reforms, and subsidies, under market economy, consumer sovereignty, and the free trade system will be necessary in future.

Notes

1) The Cabinet Office, Government of Japan. 2006. "The Special Public Opinion Poll about Food supply."
2) Higuchi. 1991. "Japanese Dietary Habits and Food consumption", in the Committee for the Japanese Agriculture Session, XXI IAAE Conference (ed.), *Agriculture and Agricultural Policy in Japan*, Tokyo, Japan: University of Tokyo press, PP. 87-104.
3) Naomi Saeki. 1991. "Development of Trade in Agricultural Products and Border Adjustment in Agriculture", by the Committee for the Japanese Agriculture Session, XXI IAAE. Conference (ed.), *Agriculture and Agricultural Policy in Japan*, Tokyo, Japan: University of Tokyo press, PP. 121-142.
4) Ministry of Agriculture, Forestry, and Fisheries of Japan. 2007. "Annual Report on Food, Agriculture and Rural Areas in Japan, Fiscal Year 2007," PP. 190-191.
5) The National Institute of Population and Social Security Research. 2006. "Future Population Projections of Japan".
6) The New Basic Plan for Food, Agriculture, and Rural Areas, P.25.
7) There was a strong positive correlation between calorie supply from domestically produced food and total planted areas. Correlation coefficient was 0.93 for the period 1985-2006.