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Population and Food Strategy for 21st Century

— Asia and World —

MARCH 1997

The Asian Population and Development Association

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FOREWORD

The relationship between population and food is an eternal concern of human beings. Human history reveals a repetition of shift between collapse balance and its recovery. After World War II, however, the global food production capacity achieved a historically remarkable breakthrough despite the precarious political climate under the cold war.

In the meantime, world population also began to show unprecedented increases. The annual average growth in world population over the fifteen years from the 1960's to the first half of the 1970's reached 2%. The figure has since declined to as low as 1.48% today (1990 to 1995). Worldwide food production, on the other hand, recorded an annual increase of 3%, far higher than that of population, over the thirty-five years from 1950 to 1984. This manifested the likelihood that men would no longer have to suffer from food shortage, a deep-seated threat to their life.

During the decade from 1984 to 1993, however, grain production suddenly fell to as low as an annual increase of 1%. Scientific technology that had enabled extraordinary increase of food production began to show its inability to maintain the low of increasing returns shit to diminishing returns and natural restrains is now emerging.

Imbalance between population and food does not simply refer to certain local areas or nations. It is the key to the survival of all human beings in the face of rapidly increasing global population. World population of 5.8 billion (1996), an annual increase of over 80 million, nearly 10 billion by 2050, which are terrible figures threating the survival of human being.

900 million people in the world are reported to the human crisis from every possible angle with the cooperation of many specialists. Based on Asian population in particular, we have forecast food demand and supply and suggested what measures need to be taken in the future. We hope that this opportune research will be of service as helpful guideline.

Finally, allow me to express my sincere thanks to The Nippon Foundation (Ms. Ayako Sono, Chairman) and United Nations Population Fund (Dr. Nafis Sadik, Executive Director) for their immense support on the preparation of this report.

March, 1997
Fukusaburo Maeda
Chairman
The Asian Population and
Development Association

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Summary

The Balance of Population and Food
Mankind's Final Choice

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Remarkable historical changes concerning the population have occurred during the last decade of the 20th century. Firstly, there was the problem of food which would directly effect our lives. The second problem was to control the increasing numbers of people needing food. A policy of 'Female Empowerment' was adopted at the Cairo Conference in 1994 (a United Nations conference on population and development) with the express purpose of raising and improving the lot of women. This policy was adopted as a comprehensive strategy aimed at resolving the population crisis by radically improving the position of women in society, the economy and health. I consider these measures for women as a comprehensive and progressive idea i.e. 'the development of women'.

As an analogy, you could consider both of these problems as the wheels on either side of a car; if the balance is not maintained, the car is likely to go out of control.

The third issue is the United Nations projections that the global population will reach ten billion by 2050, an unprecedented level, which is causing concern internationally as well as amongst the experts, as this figure is nearly double the 5.3 billion total in 1990.

When it was said that the global population will reach ten billion, what we were first concerned about is whether the earth can tolerate such a huge number of people. In other words, would it be possible to produce sufficient food? These problems have already been covered by experts as follows:

1. "Can the growing human population feed itself?", John Bongaarts (1994)
2. "Full House - Reassessing the earth's population carrying capacity", Lester Brown (1994)
3. "How many people can the earth support?", Joel Cohen (1995)
4. "Surpopulation - Mythe ou Menace", Klatzmann [France] (1996)

   All of the above are typical recent works about the intertwined problems of population and food.

In 1994, the United Nations 1992 projections of the future world population was revised downwards from 10 to 9.8 billion for 2050, but that is still a huge number. On the other hand, however, against this slight easing of the increase numbers, IIASA projected world population at 11.3 billion. IIASA's projection is rather closer to the high variant of the 1994 UN projections of 11.9 billion. These notable differences in projections are mainly the result of differing assumptions of future fertility rates between the United Nations and IIASA.

In any event, we need to prepare for the possibility that the global population may double from its current level of 5.8 billion to about ten billion within the next half century.

Malthus devised his depressing theory on the relationship between population and food approximately 200 years ago (1798). Fortunately, however, mankind was able to rapidly increase its food production through the industrial and agricultural revolutions, and its increase rate was much higher than the then low increase rate of the population, resulting in an abundance of food. Although the population increased rapidly after the Second World War, food productivity increased much more rapidly through modern scientific developments, and the global food consumption per person increased. The concerns in those days were about surplus agricultural production and a consequential slump in prices.

The situation began to change in the early nineties. There are several signs indicating a limit to the amount of food production that can match the population increase. The potential imbalance between population increase and food production resulling food shortage which was proposed by Malthus may soon become reality on a global scale. After the second edition of his theory on the population, Malthus also suggested the possibility of mankind's survival by controlling the fertility by themselves to cope with the food shortage. Today, 200 years later after he laid out his theory, the looming global crisis that may affect mankind's very survival may be even worse than Malthus anticipated.

A serious debate on the issue of whether the earth can actually sustain a population of ten billion people has begun with works by John Bongaarts (1994), Lester Brown (1994), and Joel Cohen (1995). In 1994, the United Nations revised its 1992 projections on the global population of 2050 to 9.8 billion from ten billion. On the other hand, IIASA projected the global population for 2050 at 11.3 billion as they anticipate difficulties in reducing the fertility rates in developing countries (1994). This figure is closer to the high variant of the UN projections of 11.9 billion. In any case, this is the magnitude of the global population that is considered as the most probable total within half a century.

Expanded food production is the first priority if we are to consider the possibility of ten billion people surviving on earth. No definite conclusions have been drawn yet as opposing pessimistic and optimistic theories coexist, involving complicated positive and negative factors, such as the possibility of expanding the available cultivated land for food production, discovery of many varieties of high yielding crops, use of chemical fertilizer for increased productivity, and unprecedented food production increases through bio-technology. However, many experts point out that the increase in global food production has begun to slow down or even decrease, while on the other hand, the global population will continue to increase for at least the next half century, and if it is going to reach ten billion, the serious issue of the food problem cannot be avoided.

The green revolution enabled the rapid increase in food production, but it was only a temporary solution. 'Limits to Growth' by the Club of Rome (1972) predicted a food shortage which would occur despite the development of new agricultural technology, and we would face a 'Malthusian Solution' through an abnormal increase in the mortality rate and because of the deteriorating environment.

The world's population increased at a rate of approximately 2% annually for a fifteen year period from the early sixties to the mid seventies, which was

the highest recorded level in history. However, the increase rate continued to decline slowly but surely after this fifteen year peak, and fell to an average of 1.57% annually by the early nineties, according to the United Nations' estimation in 1994. The United Nations projects that the world population increase ratie will continue to fall and reach to an annual average of 0.51% in the period 2045-2050. While it is certainly preferable that the world population increase rate should fall to 0.5%, the increase rate in developing countries, which account for 80% of the world's population, would need to fall to 0.6% annually by then. The current increase rates (1995 - 2000) are 2.7% in Africa, 2.0% in Central and Southern Asia, and 2.4% in Western Asia, so it would not be easy to reduce those rates to less than half in Africa, a quarter in Central and Southern Asia, and a third in Western Asia.

However, a more serious challenge may be presented by the tremendous annual increase in numbers (see Table and Figure). Although it is estimated that the annual increase rate will continue to decrease despite this decline, the annual increase in the world's population will reach a staggering figure of 80 to 90 million per annum for the 45 years from 1980-85 to 2020-25. The total increase in this 45 year period will be nearly four billion. It can safely be said that the 30 year period from 1995 to 2025 will be the most critical. The question is whether it is possible to provide food, housing, employment, health and medical services for such an enormous annual increase in the number of people. The food problem will have an especially direct effect on our lives.

Human beings are not different from other creatures. We can exist only under biological low. Eventually, we human beings cannot conquer nature. Serious reflection about how to create symbiosis with nature from the standpoint of global perspective will be a starting point of solution. Challenge for future of mankind would be meaningless, unless mankind do not make efforts to understand for themselves what they are (Sagan).

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Joseph Klatzmann: Nourir dix Millards d'hommes? 1983

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Global Population Increases shown in Rates and Figures.

1950 - 2050

Period	Population (millions)	Average annual increase (%)	Average annual increase (millions)	Period	Population (millions)	Average annual increase (%)	Average annual increase (millions)
1950 - 55	2754.2	1.78	46.88	2000 - 05	6594.4	1.37	87.26
1955 - 60	3021.5	1.85	53.46	2005 - 10	7032.3	1.29	87.58
1960 - 65	3337.8	1.99	63.26	2010 - 15	7468.9	1.20	87.26
1965 - 70	3697.1	2.04	71.86	2015 - 20	7887.8	1.09	83.78
1970 - 75	4077.0	1.96	75.78	2020 - 25	8294.3	1.00	81.30
1975 - 80	4444.3	1.73	73.48	2025 - 30	8670.6	0.89	75.26
1980 - 85	4846.3	1.73	80.40	2030 - 35	9013.8	0.78	68.66
1985 - 90	5284.8	1.73	87.70	2035 - 40	9318.2	0.66	60.86
1990 - 95	5716.4	1.57	86.32	2040 - 45	9587.3	0.57	53.82
1995 - 2000	6158.0	1.49	88.32	2045 - 50	9833.2	0.51	49.00

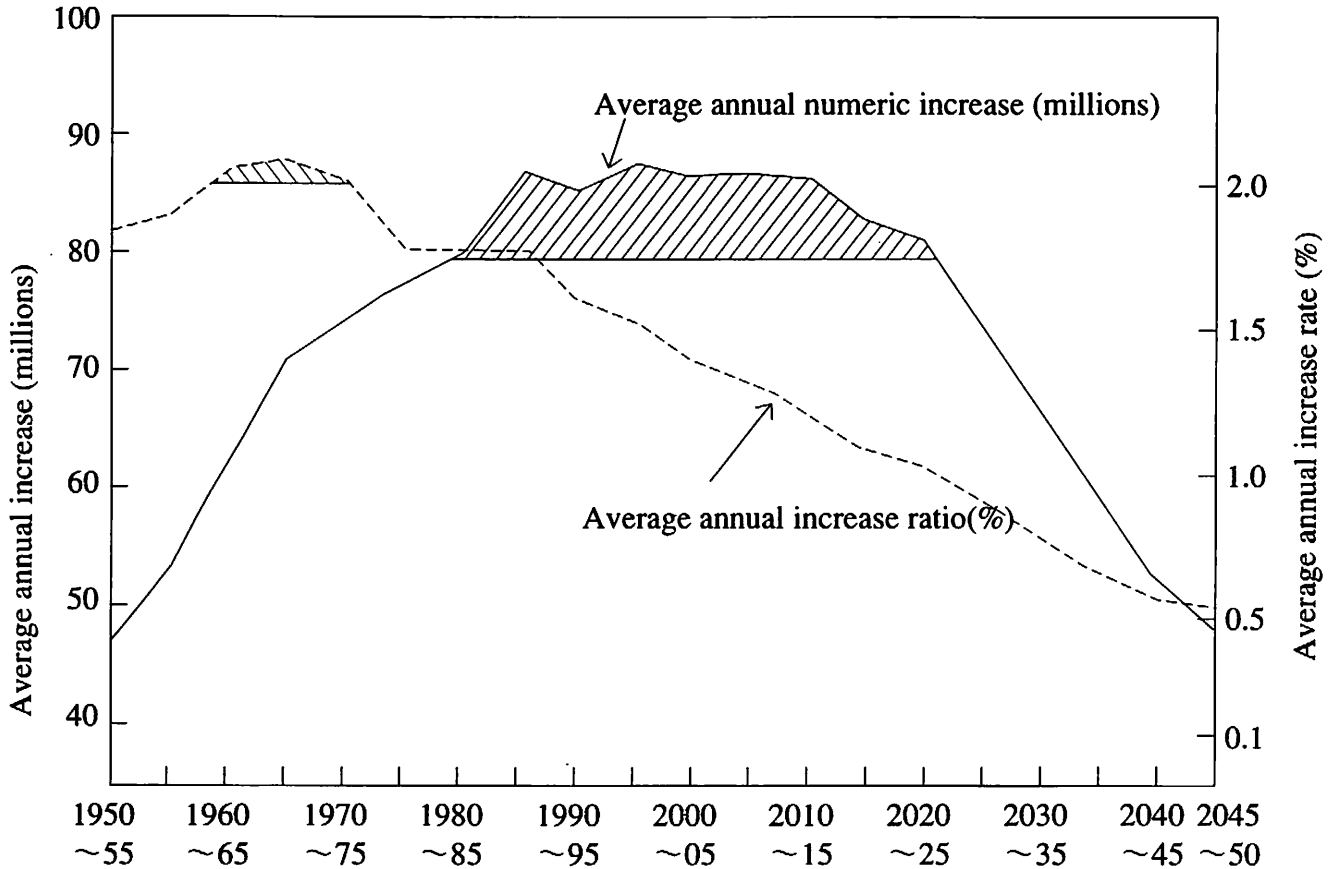
Source : Based on 'World Population Prospects, The 1994 Revision', United Nations.

Remarks : Populations quoted are for the last year in each period, and population increases and rate represent the average of each 5 year period.

The population increase rates in the developed regions will be negative from the 2025-30 period onwards.

The gap between the annual increases and the rate of the world population
(1950-55 ~ 2045-50)

24th May, 1995
Toshio Kuroda



Source : Based on the United Nations 'World Population Prospects, The 1994 Revision'

Chapter One

Balance in the World

-Population and Food-

Current and Future States of the World Population

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1. Current World Population

According to the UNFPA (The State of World Population, 1996), the current world population (in 1996) has increased to 5.8 billion compared to a population of 2.5 billion in 1950. Within the last half century, the population has increased 2.3 times, representing an annual increase of 1.8%. This world population explosion since the second world war has never previously been experienced throughout the long history of mankind. It is believed that ever since mankind first settled down to form farming settlements, several thousand years before Christ, the global population has increased. However, the rate of increase was never as quick, and natural phenomenon had always held it in check resulting in frequent peaks and troughs. It has been estimated that the world population in 1650 was 0.5 billion, and roughly since that time, the increase has been continuous. The rate especially increased after the Agricultural Revolution, at the start of the Industrial Revolution, in the mid-eighteenth century. It reached 0.8 billion by 1750, 1.3 billion by 1850, and 2.5 billion by 1950. Although there was a five-fold increase within the 300 years from 1650 to 1950, the annual increase was only 0.5%. Therefore, it is clear that the current annual 1.8% rate of increase since 1950 is phenomenal in mankind's history.

The feature of the world population since the second world war is not only its remarkable increase, but also the population distribution area and the significant differences in the growth rates between areas. The United Nations distinguishes countries as developed nations (Europe, North America, Japan, Australia and New Zealand) and developing nations (the remainder) [See Table 1] , and the distribution of the world's 5.7 billion population is 1.2 billion (21%) in the developed nations, and 4.5 billion (79%) in the developing nations. The population distribution of the 2.5 billion in 1950 was 0.8 billion (32%) in the developed nations, and 1.7 billion (68%) in the developing nations.

The world population increased by 3.2 billion within 45 years, from 1950 to 1995, split as 0.4 billion in the developed nations, and 2.8 billion in the developing nations. Thus, the world population increase after the second world war has mainly occurred in developing nations.

When we look at the increase rate over each five years [Table 1] to understand the situation in more detail, although we see some change in the overall percentage increase from 1950-55 to 1990-95, it is not particularly large. However, if the developed and developing nations are separated, there are some more obvious differences and changes to be seen. The rate of increase in the developed nations gradually declined annually from 1.20% in 1950-55 to less than one percent (0.82%) in 1965-70, and fell to 0.40% in 1990-95. In the developing nations, the rate of increase has been constantly above two percent annually, from 2.05% in 1950-55 to 2.06% in 1985-90, with the increase rising to 2.52% in 1965-70. However, after recording 2.37% in 1970-75 it started dropping, and the rate of increase fell remarkably especially after 1975. Then it fell under 2% for the first time in 1990-95 (1.88%).

There where periods of population increases in the developed nations by demographic transition after the Industrial Revolution, but it rarely exceeded two percent as an annual rate of increase even at that stage. Also, those population increases were induced by economic development, which in turn had the reciprocal effect of further accelerating that same economic development, and it has never been a hindrance in the same way as the current population increases in the developing nations. By comparison, the existing population increases by external causes before economic development got on the right track, and the remarkable increase of two percent annually are the current problems of the developing nations.

The world population situation needs to be considered in more detail by splitting it up into separate areas. The world population is far from level, for as you can see when the population is split up into the five continents [Table 2], in 1995 there were 3.5 billion people (61%) in Asia, 0.8 billion (14%) in America, 0.7 billion (12%) in both Africa and Europe, and only 30 million

(0.5%) in Oceania.

The difference in the rate of increase is even more remarkable than the population distribution. Previously we mentioned the difference between developed and developing nations, but now we'd like to concentrate on the significant differences within the developing nations. From 1950 until now, the increase rate has been high with almost no signs of a decrease in Africa, and Central, Southern and Western Asia, but we can see a slight decline in the rate in Latin America and South-East Asia. The population scale is large in East Asia, but the rate of increase is certainly falling recently.

Generally, although there differences from area to area as indicated above, significant changes occurred around 1975. The 'World Population Action Plan' was first adopted at the 'United Nations World Population Conference' held in Bucharest, the capital of Rumania, in 1974. This was completed by agreement of each attendant nation to promote economic social development and population policies to solve the world population problems. Although there was no worldwide agreement on recognition and policy regarding world population problems, circumstances were changed by this conference. We could clearly see the results through the situation reports of each participant nation at the 'International Population Conference' held in Mexico City ten years later. That was the background to the decline of the population increase rate in many areas of the world, as shown in Table 2, with 1975 being a water-shed year.

2. Future World Population

How the world's population changes in the future is the main issue. The United Nations has announced its estimation for the future world population fourteen times; first in 1951 and most recently in 1994.

The UN estimation in 1994 uses 1990 as its starting point, and covers up to the year 2050. [Table 3] According to this estimate, the world population would reach 5.7 billion by 1995, 6.2 billion in 2000, 8.3 billion in 2025, and 9.8

billion in 2050. The world population is likely to reach nearly 10 billion in the middle of the next century. It is not easy to say whether this number is acceptable, or extraordinarily large.

By comparison, this estimation is a little less than the UN one of 1992. It is 70 million less in 2000 compared to 1992's estimate, and 180 million less by 2025. This is the result of estimations which reflect the sharper than expected decline in the global birth rate, and its significant effect.

When we consider the future world population separated by area, although the developed nation's population is increasing slightly, the rate is quite small and most of the increase will occur within the developing nations. The world population will increase by 4.1 billion from 1995 to 2050, of which 41 million is in the developed nations, and the remaining 4.07 billion is in the developing nations. The population distribution ratio between developed and developing nations is 20:80 in 1995, but will be 12:88 by 2050.

A significant difference can be seen in the future rate of increase within developing nations. In Africa and Western Asia, the annual increase will continue to exceed two percent for some time, but other areas, like East Asia, are expected to fall below one percent in the near future. Then the increase rate for all areas is expected to fall below two percent by the middle of next century.

The UN's 'Future Population Estimation' is calculated using the last accurately known population figures (1990 for 1994's estimation) as the start point, and extrapolating them using anticipated birth and death rates. In this case, both birth and death rates are gradually expected to decline. Therefore, the reason that the population's increase rate falls in any area is due to the rate of decline of the birth rate exceeding that of the death rate. Those estimations may be overly optimistic. If the food supply increase does not keep pace with the population increase, there is a fear that the Malthusian population law, which decrees that the death rate will increase, will come into effect. However, of course the future population figures announced by the UN have never taken that into account.

3. The Relationship between Population and Food

It goes without saying that as the population increases, so does the demand for food. However, it is necessary to note that increased food demand per capita results from increased income. This is clear when we look at the graph of Table 4. By dividing the listed nations into four groups; namely Low Income Countries (from Ethiopia to Egypt), Lower-Middle Income Countries (Indonesia to Botswana), Upper-Middle Income Countries (Venezuela to Portugal), and High Income Countries (New Zealand to Switzerland); and calculating the relationship between average income per capita and daily calorie intake (Calorie intake amount = (A + B) x Average Income), where the value of 'B' is 1.80 for low income countries, 0.27 for lower middle income countries, 0.11 for upper-middle income countries, and -0.01 for high income countries. It is certain that food demand per capita will increase as the national average income rises.

Clearly, the world population increase rate has been in decline since the 'World Population Conference' in 1974. However, the population increase cannot be suddenly halted as it has a certain inertia. The world population will continue to increase for some time as the UN future population estimation shows. Additionally, with global economic development, food demand per capita may increase, especially within developing nations where the population is rapidly increasing. As a result, the total global food demand may increase at a higher rate. Whether or not the world food supply will be sufficient is the next big issue.

Table 1 World population

Year	Population (million) World	Developed nations	Developing nations
1950	2520	809	1711
55	2754	859	1896
60	3021	911	2111
65	3338	962	2376
70	3697	1003	2695
75	4077	1044	3033
80	4444	1080	3364
85	4846	1111	3736
90	5285	1143	4141
95	5716	1167	4550
Period	Population Increase Rate (Annual) [%]		
1950-55	1.78	1.20	2.05
55-60	1.85	1.18	2.15
60-65	1.99	1.10	2.36
65-70	2.04	0.82	2.52
70-75	1.96	0.81	2.37
75-80	1.73	0.67	2.08
80-85	1.73	0.56	2.09
85-90	1.73	0.58	2.06
90-95	1.57	0.40	1.88

Note : 1995 is estimated value

Source : UN, World Population Prospects : The 1994 Revision

Table 2 World Population by Area

Population (million)	1950	1960	1975	1985	1995
Worldwide	2520	3021	4077	4846	5716
Africa	224	282	414	549	728
America	332	416	559	663	775
Latin Amerima	166	217	320	398	482
North America	166	199	239	265	293
Asia	1403	1703	2406	2904	3458
East Asia	671	792	1097	1259	1424
Central/South Asia	499	621	886	1113	1381
South-East Asia	182	225	324	401	484
Western Asia	50	66	99	131	168
Europe	549	605	676	706	727
Oceania	13	16	21	24	29
Increase Rate (Annual)	(1950-60)	(1960-75)	(1975-85)	(1985-95)	
Worldwide	1.83	2.02	1.74	1.66	
Africa	2.33	2.59	2.86	2.86	
America	2.28	1.99	1.72	1.57	
Latin Amerima	2.72	2.62	2.21	1.93	
North America	1.83	1.23	1.04	1.01	
Asia 1.96	2.20	1.90	1.76		
East Asia	1.67	2.20	1.39	1.24	
Central/South Asia	2.21	2.40	2.31	2.18	
South-East Asia	2.14	2.46	2.16	1.90	
Western Asia	2.82	2.74	2.84	2.52	
Europe	0.98	0.74	0.44	0.29	
Oceania	2.10	1.83	1.34	1.91	

Source Same as Table 1.

Table 3 Future Forecast of World Population by Area

Population (million)	1995	2000	2010	2020	2025	2050
Worldwide	5716	6158	7032	7888	8294	9833
Developed nations	1167	1186	1213	1232	1238	1208
Developing nations	4549	4973	5819	6656	7056	8626
Africa	728	832	1069	1348	1496	2141
America	775	830	935	1034	1079	1228
Latin Amerima	482	524	604	676	710	839
North America	293	306	332	358	370	389
Asia	3458	3736	4264	4744	4960	5741
East Asia	1424	1493	1605	1707	1746	1820
Central/South Asia	1381	1526	1817	2076	2196	2673
South-East Asia	484	527	607	679	713	851
Western Asia	168	190	234	281	305	397
Europe	727	730	729	723	718	678
Oceania	29	31	35	39	41	46
Increase Rate (Annual)	(95-2000)	(2000-10)	(2020-25)	(2025-50)	(2025-50)	
Worldwide	1.50	1.34	1.16	1.01	0.68	
Developed nations	0.32	0.23	0.16	0.10	-0.10	
Developing nations	1.80	1.58	1.35	1.17	0.81	
Africa	2.71	2.54	2.35	2.11	1.44	
America	1.38	1.20	1.01	0.86	0.52	
Latin Amerima	1.68	1.43	1.13	0.99	0.67	
North America	0.87	0.82	0.76	0.66	0.20	
Asia	1.56	1.33	1.07	0.89	0.59	
East Asia	0.95	0.73	0.62	0.45	0.17	
Central/South Asia	2.02	1.76	1.34	1.13	0.79	
South-East Asia	1.72	1.42	1.13	0.98	0.71	
Western Asia	2.49	2.10	1.85	1.65	1.06	
Europe	0.08	-0.01	-0.08	-0.14	-0.23	
Oceania	1.34	1.22	1.09	1.01	0.46	

Source: Same as Table 1.

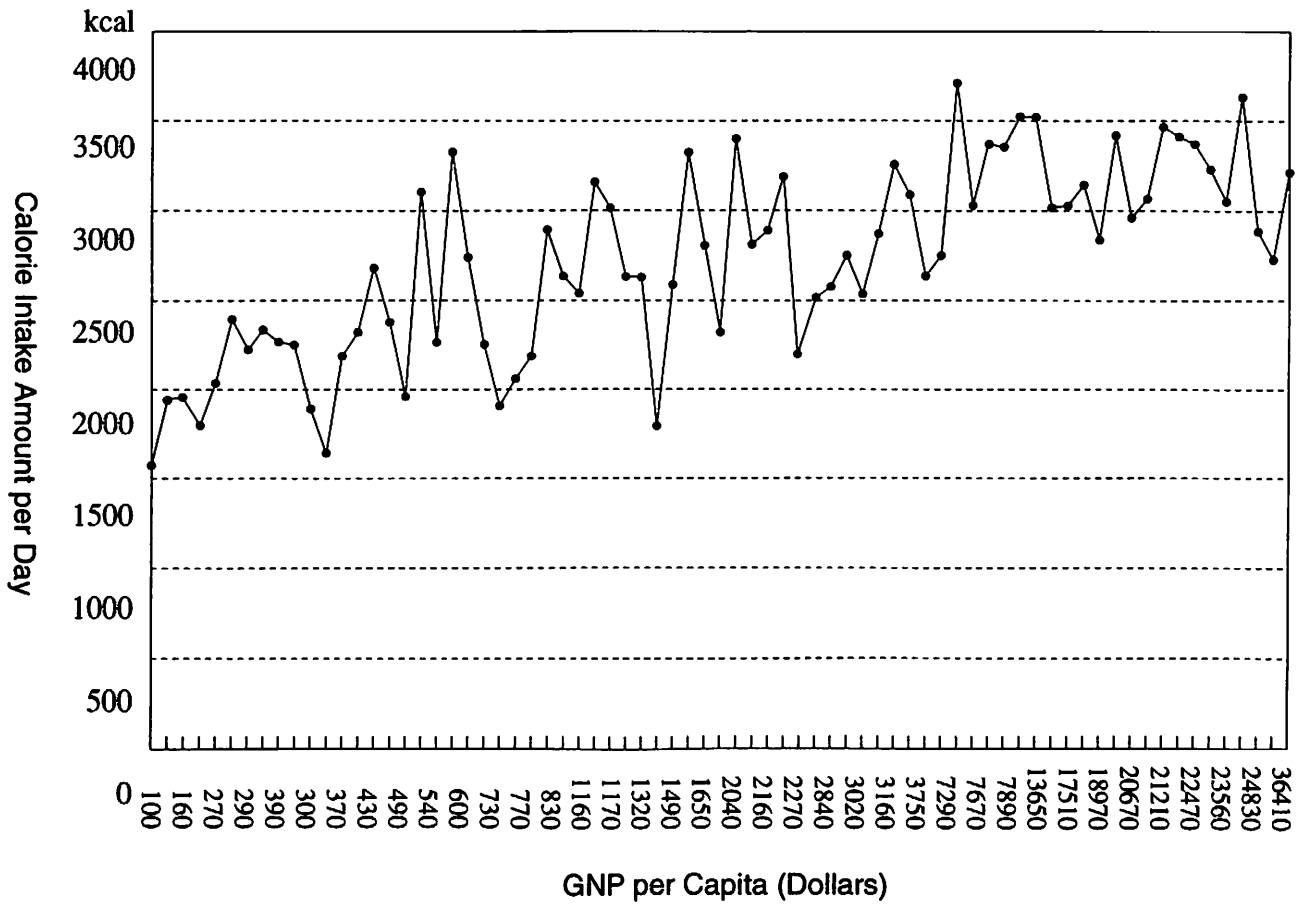
Table 4 Average Income and Demand for Food

Name of Countries	GNP per person (1993)	Kcal per day (1992)
Low Income Countries	(Dollars)	(Kcal)
Ethiopia	100	1596
Tanzania	100	195
Nepal	160	1956
Malawi	220	1812
Kenya	270	2042
India	290	2386
Laos	290	2215
Burkina Faso	300	2332
Mali	300	2272
Nicaragua	360	2259
Zambia	370	1900
Central African Republic	390	1656
Ghana	430	2177
Pakistan	430	2315
China	490	2683
Guinea	510	2384
Zimbabwe	540	1965
Honduras	580	3090
Sri Lanka	600	2270
Egypt	660	3333
Lower-Middle Income Countries		
Indonesia	730	2751
Senegal	730	2256
Cameroon	770	1910
Bolivia	770	2062
Philippines	830	2173
Rumania	1120	2891
Bulgaria	1160	2647
Ecuador	1170	2547
Syria	1170	3173
Jordan	1190	3022
El Salvador	1320	2629
Colombia	1400	2617
Peru	1490	1811
Paraguay	1500	2566
Algeria	1650	2894
Tunisia	1780	3315
Thailand	2040	2333

Name of Countries	GNP per person (1993)	Kcal per day (1992)
Low-Middle Income Countries	(Dollars)	(Kcal)
Turkey	2120	3410
Costa Rica	2160	2811
Iran	2230	2858
Poland	2270	3188
Botswana	2590	2181
Upper-Middle Income Countries		
Venezuela	2840	2501
South Africa	2900	2561
Brazil	3020	2760
Chili	3070	2524
Malaysia	3160	2878
Hungary	3330	3259
Mexico	3750	3097
Uruguay	3910	2639
Argentina	7290	2745
Greece	7390	3691
Korea	7670	3032
Saudi Arabia	7780	3352
Portugal	7890	3352
High Income Countries		
New Zealand	12900	3504
Spain	13650	3513
Israel	13760	3019
Australia	17510	3021
Great Britain	17970	3129
Finland	18970	2840
Italy	19620	3414
Canada_	20670	2973
Holland_	20710	3049
Belgium	21210	3462
France	22360	3429
United Arab Emirates	22470	3383
Austria	23120	3240
Germany	23560	3042
United States of America	24750	3583
Sweden	24830	2868
Japan	31450	2736
Switzerland	36410	3185

Source : Illustration of World Conditions 1995-96

Figure Average Income and Demand for Food



4. Hopes and fears about the supply and demand of the world's food.

When considering the global supply and demand situation, with a few notable exceptions in Africa, the food production rate managed to exceed the population increase rate until the 1980's as a result of advances in science technology symbolized by the 'Green Revolution'. However, by the mid 1990's, many people had become concerned about the balance of the world's food supply and demand, with the international grain markets facing a very tight situation as reserve stocks fell to their lowest levels ever, due in the main to the poor American grain harvest of 1995. Many people recognize that the earth's environment and resources, which are the basic requirements for food production, are limited, and against the backdrop of an ever expanding population which now stands at 5.7 billion and is expected to reach 8.5 billion by 2025, only 30 years later, they feel uneasy about the future supply meeting the demand.

The views being expressed about the global supply and demand by international institutions and agricultural organizations of leading countries are generally optimistic, with the FAO report on prospects for 2010 maintaining that malnutrition will be reduced, and the grain price will hold steady or even tend to fall. However, Mr. Lester Brown of the World Watch Research Institute gives a note of warning, saying, "The biggest menace for our future is not war, but food shortages." As if to bear him out, a report by the International Rice Research Institute (IRRI) highlights the possibility of a global rice shortage induced by a slowdown in the increase rate of rice harvests per unit. Opinions on the future prospects for world food supply and demand run to both ends of the hope spectrum, optimistic and pessimistic. Which is correct? Only time will tell.

These apparently conflicting opinions, optimism and pessimism, towards the long term prospects of global supply and demand are not necessarily totally incompatible. The optimists view covers only the next decade or so, while the pessimists are warning against one particular possibility that is relevant to a

much longer term of several decades. The long term prospects could turn out to be very different, depending on whether this is the main, or dominant, issue amongst those currently being considered, or just a passing tendency, and what happens in the next decade or the several decades after that.

5. The Cold War Structure maintained the World's Food Supply and Demand System

The basic trend of the world food supply and demand is changing in a world-wide flow which reflects the global political and economic structures. The East/West cold war had been set up on a basis of controlling the post war world food supply and demand. The world had effectively been split into two factions under the old East/West cold war structure, and a market economy was absent in the eastern bloc socialist countries, and self-sufficiency in food was attempted within the country or region.

In western countries, although a market economy has been adopted in principle, with the professed aim of achieving international free trade under the terms of the GATT agreement, many governments have actually intervened in various ways, such as price-fixing for agricultural products, production controls, or trade restrictions, in order to avoid or diminish the contradictions and negative social aspects that go hand in hand with a free market economy, as well as to prevent radicalism and socialism amongst farmers and laborers.

Amongst the developing countries, many have adopted a socialist economic plan to achieve self-sufficiency in foodstuffs, and even those with a capitalist economy have attempted to increase their own food production levels with various protectionist measures. The advanced western nations, led by the USA, have been supporting the developing countries in a bid to up their food production by organizing international agricultural laboratories such as the FAO and the IRRI. In some developing countries, such as Ethiopia, where the Eastern and Western block countries were trying to maintain their own spheres of

influence through economic and food aid, the system adopted allowed the donor nations to distribute their own surplus agricultural produce, which hindered the recipients from establishing their own long term agricultural independence, and worse still, it exacerbated their economic troubles and spurred them on to further social and political instability.

Thus the 'Cold War' between the east and west fundamentally affected the world food balance. The result, as symbolized by the success of the 'Green Revolution', was a food production increase rate that even out-stripped that of the population explosion, and the resulting optimism that was dominant in the 1980's led to the reduction of agricultural protectionism being adopted as an international theme in the 'Uruguay Round' GATT talks. It is clear that we could take an optimistic assessment if we considered our future as an extension of the policies which governed the world food balance under the cold war period.

However, in the late eighties, the cold war structure collapsed, with the failure of the great historical experiment in socialist economic planning throughout the Soviet Union, Eastern Europe and the People's Republic of China. Following this, the world food balance structure changed markedly, and the global food supply and demand system is taking a new turn, with agricultural food products finally moving into the global marketplace. Today, the principal of a liberal market economy is globally recognized as applying to all goods, and a single global market has been realized. We can say that this has arisen as a direct result of the 1972 world food crisis, the instability of the seventies and eighties, and the conclusion of the 'GATT - 1993 Uruguay Round' talks.

The world food supply and demand after 1990 can be characterized as the food supply and demand within the economic system reformation period in which the market economy has filtered into both international and domestic markets. In the future, the restrictions on the earth's resources and environment will increase due to the continuing population growth, especially in developing countries, and also because of increased food demand fueled by the economic growth seen in Asian countries, resulting in a revolution in the food production and trading systems will be advanced through the overall penetration of a market

economy. If such a total penetration of the market economy were left unchecked by any restrictions, its negative effects may be more acutely felt globally, that is to say, those inconsistencies such as the instability of the supply and demand market, increasing the gap between rich and poor, more environmental damage, etc.

It should be the main theme for mankind as we approach the 21st century, to establish how to contain and control these negative factors, while still retaining the principle of a liberal market economy.

6. Heeding the Pessimistic Warnings

The development of new agricultural production technology requires at least ten years, as not only the breed or species must be improved, but the cultivation technology must be put in place. Furthermore, a long term period of several decades accumulated experience is necessary to establish the technology needed, including locally adapted technology, in the process of its popularization. In that sense, as long as it is in the diffusion process of technology, as was shown by the way the green revolution developed and accumulated under the cold war conditions, there would be no major concern about global food supply and demand within the next decade or so, due to the current inertia of the system. But we cannot consider the food balance as a matter for only the next decade or so, as is directly indicated by the fact that the development of cultivated areas, which are the basis for agricultural production, is only the accumulation of strenuous efforts by mankind over many hundreds of generations. If we showed no concern for our present situation, and neglected our responsibilities of investing in the long term future, some kind of woe is sure to befall us and our off-spring in the next two or three decades. It would then take further decades before any counter-measures could be put in place, assuming they were possible in the confusion of the time.

The super long term prospects for 2030, as predicted by Mr. Lester Brown and others, should be taken as a warning of the above to mankind. His analysis

pays close attention to the latest trends in agricultural production, such as the decrease in the area of cultivated land in China, or the stagnation in the increase of global crop harvests, and he shows us the significance of these changes in this period of rapid economic growth for our super long term prospects.

This ominous prospect for the economy and society as a whole are warnings about the dangers lurking within the present situation, and should be viewed as an appeal to help prevent such an event happening. The announcement of these prospects is intended to ensure that counter-measures are put in place, in other words, it does not wish history to bear its prophecies out.

7. The issue of the World Food Problem

It is now widely recognized that the possibilities for increasing the cultivated area are very limited, and that it must be restricted to ensure the preservation of the environment. As has been seen recently in China, and previously in Japan, Korea and Taiwan, the most fertile farmland is being lost to other uses by its conversion into residential and industrial areas, as well as roads etc., which is the natural result of the population increases and economic growth. Additionally, the problem of diminished farmlands is further exacerbated by the increased distance between farmers and manufacturers. Many of the remaining areas with farming potential are in the tropical (heavily-forested) zones, and there are many reports of the serious adverse effect on soil conditions and the earth's own weather systems, as well as the ecology and wilderness, caused by the destruction of these forests.

Whether the unit crop ratio can continue to be increased by further use of chemical fertilizers etc. will also have an important bearing on future food production. Lately, international agricultural organizations such as IRRI have tended to trim their research spending and reduce their staffing levels significantly, but how will this affect the increase rate of unit crop harvests through product development? How will reduction in irrigation investment

relate to agricultural production in the long term? Can the expansion of the desert, estimated at 6 million hectares per annum, be held in check? There are many things to be worried about which may effect food production in the long and extended long term, such as what effect global warming has on the supply and demand of food etc. As far as these issues are concerned, the key research has hardly even begun, especially in the global sense. Studies into the particular issue of future demand, specifically the speed of change in the balance of the food and agricultural produce system in those rapidly developing Asian countries, notably China, and its influence on the international market, are only now just being started, as indicated by the two opposing views of optimism and pessimism.

Also, in the worldwide flow towards a free market economy, it is still necessary to deal with political issues such as how to overcome the increasing distances between farmers and their manufacturing partners, or how to achieve a new global balance that resolves the problem of hunger and malnutrition suffered by the poor and land-less farmers in sub-Saharan Africa, South Asia, and Latin America by considering them all as a common problem for mankind, quite aside from trying to prevent a return to the type of socialism that existed during the cold war era.

Furthermore, policy directions under the free market economy must be unambivalent, after resolving such issues as how political intervention by governments influences the global food balance or environmental matters, and what sort of international cooperation is required to control the population, agriculture, forestry and fisheries. In this case, it is not only important to determine the direction of their technological development, but also to support them in forming their food and trading policies, such as setting up long term goals to achieve self-sufficiency in foodstuffs, without being pressured by the short term policies of the advanced food exporting countries to ensure disposal of their surplus.

Chapter Two

World Population

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1. Theme of the Chapter

Given title of the chapter is World Population. Since the title of the book is Food and Population, it is expected that a point of discussion will be focused on such problems as the relations between world population and food supply in the past and how much population is expected to grow in the future, and also if there is room for its growth. Therefore, in this chapter discussion will be made on the world population trends from past, present, and future as well as on important problems the world is facing today and the carrying capacity of the earth. Finally, from the demographic point of view, the world population's future as to where we as mankind are heading for will be discussed.

2. Trends of World Population

According to the World Population Prospects (1994 edition) of United Nations Population Division, the world population as of July, 1996 was 5,804.2 million. It was approximately 1930 when the world population reached 2 billion (see Table 1). It is not certain exactly how many years passed since mankind originated, but it is said that it was about 150 thousand years ago when homo sapiens, present mankind, appeared on the earth. Therefore, this means it took 150 thousand years for the world population to reach first 2 billion. However, in 1975, it marked 4 billion and means it took only 45 years to add next 2 billion since 1930. And then, according to previously mentioned United Nations' projections, it is projected that it will take only 24 years, which will be in 1999, to add another 2 billion, to hit the 6 billion mark. Anyway, it seems certain that the world population will pass the 6 million mark around the year 2000. Moreover, according to the U.N. World Population Prospects, it is projected to become 9.8 billion in 2050 (see Table 1).

According to Durand's (John D. Durand) projections, the average annual

world population growth rate for 50 years (1900-1950) is only 0.8%. However, since 1950, the growth rate has increased rapidly. According to the U.N. World Population Prospects shown in table 2, from 1950 to 1955 the growth rate was 1.78% and it rose to 2.04% for the five year period from 1965 to 1970. By looking separately between the more developed and less developed regions, the annual population growth rate of 1965 to 1970 for the less developed regions (Africa, Asia excluding Japan, Latin America, Oceania excluding Australia and New Zealand) was 2.52%.

In this connection, the growth rate for the more developed regions (Europe, North America, Japan, Australia, and New Zealand) for the same period was 0.82%. If the world population increases at the rate of 2.5% for the coming 850 years, as Coale(Ansley J. Coale) figures that the total weight of all mankind will become equal to the mass of the earth. This shows the problem with the growth rate of developing region these days. The reason behind the increase of the world population growth rate at such a high percentage as 2.04% is that the death rate, which was quite high before the war in developing regions that made up 2/3 of the world population, dropped drastically by the after effects of the medical revolution taken place in Europe and Northern America while the birth rate stayed as high as before. In other words, natural growth rate was expanded.

However, after the period of 1965 to 1970, the world population growth rate started to decline. The rate dropped down to 1.73% for one time for the period of 1975 to 1980, but for 15 years from 1975 to 1990, it kept at the same level. Though there is no room for a detailed explanation of the causes, the drop of the death rate in developing regions while the birth rate in both the more developed and less developed regions is dropping still has a great effect. However, from the period of 1990 to 1995, dropping of growth rate has been seen and as table 2 indicates, it is estimated that the rate will drop down to 1.00% for the period of 2020 to 2025.

However, lately the population growth does not show a decline even though the world population growth rate is declining. As table 2 clearly shows

from the period 1965 - 1970 to the period 1985 - 1990 the population growth is expanding and for the period of 2010 - 2015, an annual population growth of approximately 87 million is projected. This situation is as if a little less than the present population of Mexico is added each year. This effect is called population momentum. This means that even though both birth rate and growth rate are declining in developing region, the total number of population is still growing. Moreover, the population is a typically pyramid-shaped and the number of women who are at the reproductive age is great. Hence, even if the fertility and growth rate are lessened, the number of new-born babies is greater than ever before. However, the effect of population momentum will start to weaken by the year 2015 and by the middle of 21st century, the annual number of growth is projected to be a half of that of present time.

3. Population Explosion in Developing Region and Efforts for its Stabilization

Speaking of population problems in Japan, it is expected that such problems as ageing population, decreasing number of children, and a population decline of the 21st century will come up. However, by looking at the whole world, the world population, especially the exploding population growth of developing regions which lead to increase poverty and environmental degradation, is a far greater problem on the global scale. The unprecedented drop in the birth rate and the expanding older population in advanced regions are serious problems by themselves. Yet this should be considered to be a rather minor problem compared to the situation in which every year almost 90 million people are added increasing the burden on the capacity of the earth. (By the way, in the future in China and India, as results of the birth rate dropping, problems of an expanding older population could possibly be serious, but if it happens it will come much later in India.) Moreover, the facts indicate the seriousness of the matter that 95% of the world population growth is taking place in poor, developing regions.

As mentioned before, a sharp population growth in developing regions is caused by the situation when the birth rate is quite high and its decline was slow, while the death rate after the war dropped more remarkably than it was expected.

Of course, besides that, the effect of population momentum, also mentioned previously, that is accumulated base population from pre-war time to present is huge and is an important factor. However, whichever it may be, trends of the future world population can be said to depended on the degree of falling of the birth rate in developing regions from now on.

Therefore, it is necessary to consider the tendency of the past, in both the developing and developed regions, and future projected trends by using the total fertility rate as an index. Table 3, based on U.N. Population Prospects, shows the trend of total fertility rates in both developing and developed regions separately.

Total fertility rate is the sum of age-specific birth rates at the time and allows for the elimination of influence of age composition. This rate, if it remains constant for a long period of time, becomes an index of the average number of children each woman should have through her reproductive period.

By the way, for developing regions, the total fertility rate (TFR, abbreviation for total fertility rate is used from now on) was quite high (6.13) for the period of 1950 - 1955. However, after around 1970, it started to drop remarkably, and was 3.83 for the period of 1985 - 1990 and 3.48 for period of 1990 - 1995. On the other hand, for developed regions, it is noticeable that TFR dropped relatively sharply.

Because of the drop took place in both developing and developed regions, the world wide TFR dropped from the level 5 to 3. Among developing countries, the decline in TFR is so remarkable, particularly for East Asia (including China), South East Asia, Central America, and the Caribbean islands. However, for those countries such as Sub-Saharan countries in Africa, Middle Eastern countries, Pakistan and Afghanistan and the subcontinent of India, TFRs are still very high. Especially for Sub-Saharan countries in Africa, the

average TFR is as high as 6.30 for the period of 1990 -1995 and the conditions for lowering the birth rate are not readily seen as fully developed.

Generally, the level of TFR is highly correlated with the prevalence rate of family planing in the country or region. According to a report made by U.N. Population Division in 1996, for those couples where the woman is age 15 to 49, 53% of the couples in developing regions are practicing birth control. Among them, as high as 79% of those couples in East Asia are practicing it. Also that of Latin America and Caribbean island countries is as high as 59%. On the other hand, for Sub-Saharan countries in Africa, only 13%, which is very low, are practicing it. Those of Northern Africa and Asia excluding East Asia are 39% and 43% respectively. Among developing regions, Sub-Saharan countries in Africa stands out for its very low rate of birth control.

The U.N. medium variant population projections project that by the year 2040, TFR for developing regions will drop to 2.14, which is a level of the population replacement. In other word, it is the fertility level which can replace the previous generation in one to one. In some sense it seems a rather optimistic projection to have such a substantial decline in fertility in developing regions, but for it to come true Sub-Saharan countries in Africa must experience a remarkable and fast drop of TFR such as 3.34 for the period of 2020 - 2030, and 2.50 for the period of 2030 - 2040. To attain those figures, contraceptions, of which the prevalence rate is only 13% now, must increase up to around 50% and 70% for those periods respectively. Then, is it really possible for such a large scale use of contraceptions to progress in this vast continent where people are extremely poor today, women's educational level are low, patriarchal family system are so strong, and also society's infrastructure is so fragile? It does not seem to be necessarily guaranteed.

One of the leading theories up to now, concerning population change, death rate, and birth rate, was population transition theory. This is a inductive theory where the structure is based on a history of a decline in death rate and birth rate in Europe. It is a hypothesis that the change from high birth and death rates, through high birth and medium death rates, to lower birth and

lower death rates will inevitably take place anywhere, even outside Europe along with modernization of society, which includes industrialization, urbanization, and improvements in the standard of living. Actually the transition from high birth and death rates to low birth and death rates has been completed in Japan and Asian NIEs. It is also noteworthy that the transition is coming to completion in ASEAN countries, Latin America, and the Caribbean islands. Truly, " development is the best contraceptive."

On the other hand, however, if it is so, those countries which are not experiencing modernization or development cannot attain low birth rates. For example, the declining of birth rate cannot be expected in Africa's Sub-Saharan countries for some time. However, according to the expert view by Freedman (Ronald Freedman) and associates at the University of Michigan, it is possible to expect a rising of the prevalence rate of family planning and a decline in birth rates in those areas where economic-social development is not fully progressed if there is a strong leadership spreading family planning among the people, with a large-scaled, effective organized efforts. Also there must be medical service centers available in individual regions where people can get the supply and services of modern contraceptive methods such as birth-control pills, IUD, and other implant able and injectable type of contraceptions.

It is interesting to see the remarkable birth rate decline in those regions which development is progressing slow and are not necessarily affluent, such as the Matlab region in Bangladesh and the Chegolia region in Kenya as a result of high quality medical services being made available and well-organized activities for spreading family planning. It suggests that there is a possibility of obtaining the similar result even in Africa's Sub-Saharan countries if a good quality of organized educational and medical activities is practiced.

According to the U.N. Fund for Population Activities, there are as many as 120 million couples in developing countries in the world today who are not practicing family planning, even though they wish to avoid unwanted births or postpone births, simply because they don't have knowledge of birth control or contraceptive pills or because devices which are safe, effective, comfortable,

and affordable are not available to them. According to the State of World Population in 1994, from the U.N. Fund for Population Activities, if their ummet needs were met for couples in these situations, the prevalence rate of family planning would be expected to rise from the current rate of 55% (estimated 53% by U.N. Population Division) to 67%. The prevalence rate of contraceptions for developed countries is currently 71%, and therefore 67% means that its rate is very close to the rate of developed countries. If it is achieved in the near future and the high practice rate is kept to be continued, then the birth rate of developing countries is estimated to decline ultimately to a level close to developed countries, which is at a population replacement level.

By the way, in Africa, it is reported that unmet needs are not so great. According to the result of the Demographic Health Survey given recently in 20 countries of Sub-Saharan African countries, only an average of 44% of the couples (including practicing couples) want to practice family planning. This is quite low compared to average of 67% in 8 countries in Asia, excluding East Asia. Unmet needs in Africa's Sub-Saharan countries is 29% which is high by itself. However, even if those needs were met, more than a half of the couples are ignorant on family planning and they are not enthusiastic about practicing it. Nevertheless, in order to achieve a birth rate of 3.34 by the year 2020 and 2.10 by 2040 in Africa, as the U.N. medium-variant projections, it seems necessary not only to work on the supply side to meet their unmet needs, but also to work on the demand side as spreading family planning on a wider range in a well organized manner.

4. Long-range World Population Projection

The U.N. Population Division prepared long-range world population projections from 1990 to 2150 for each major region and large countries (China & India) (see table 4). These projections were made based on 1990 world population prospects which was published prior to those in tables 1 and 2.

For this reason, there are minor differences on numbers on the tables but the general trend stays the same. Table 4 indicates seven different projections, based on the assumptions of different birth rate change. While the medium variant projections expect that TFR for Africa would decline to 2.04 by 2045-2050, the high/medium projections assume that TFR may not decline to 2.17 level until 2095 - 2100. On the other hand, however, the high-variant projections for Africa, indicates that it would decline to 2.50 by 2045 - 2050, while the low-medium variant shows its decline down to 1.96 by 2095 - 2100. The low variant projections project a decline to 1.70 level by 2035 to 2040.

Attention should be paid here that projections were made using different assumptions which are for medium, high/medium, high variants and those of analytical variants where NRR=1.0 which is a level of population replacement, and finally those of the constant fertility of 1990.

According to medium variant projections, the world population would reach 11.5 billion by 2150 and by the last half of 22nd century it would become the 12 billion level and then get stabilized. On the other hand, high/medium variant projections suggest that it will not stabilize until later. In 2150, the population would reach 20.8 billion which is 80% more than what the medium-variant projections. According to the high variant projections, the world population would reach 28 billion in 2150 and it would not stabilized at all. On the other hand, projections made using the constant birth rate of 1990, show that the world population in 2150 would be 694.2 billion, an incredible number.

Finally, though out of order, according to the projections made under the assumption of NRR=1.0, even that population continues to grow for a while and population of 2150 is estimated to be 1.6 times more than that of 1990. This is what is called population momentum, population increase by inertia.

Among the above mentioned future world population projections, the medium variant projections seem to project fertility decline in developing regions and it seems to forecast rather optimistically for Africa. Therefore,

the high/medium variant projections are considered to be more realistic. If that is the case, the world population in 2150 is 20.8 billion and some increase for years after is inevitable. Then, the next problem will be whether there are enough supporting resources for the world population to support more than 20 billion people. This will be discussed in the next section.

By the way, Figure 1 indicates long-term projections for the world population growth rate. From prehistoric age to the present, its characteristic is that up till the 18th century, the population growth rate had been always quite low. If U.N. projections are correct and world population growth stays as low in the future, then it means throughout several million years of history of mankind, it was only for a short time, which is less than a hundred years from between 20th century to the first half of 21st century, when population growth rate exceeded 1%. Therefore, it means that those who received life in the present time are blessed with the supreme opportunity to live in such a precious age and to witness the most dramatic change in the history of population.

5. Carrying Capacity of the Earth

How many people can the earth support? This is an old yet new problem. According to "How many People Can the Earth Support? " (W.W. Norton & Company, 1995) which was written by Cohen (Joel E. Cohen) recently, the first man who figured out the supporting resources for the world population was a Dutch man, named Leeuwenhoek who was known as the inventor of the microscope, and in 1679, he figured it out the number of 13.4 billion. This was obtained by multiplying the population density of Netherlands, which was the highest in the world in those days, by area of surface of the earth which is livable. However, it is interesting to see that today, more than 300 years after his time, world population projections made recently by the U.N. and Bank of World projected (U.N. for 11.5 billion, & Bank of World for 11.4 billion) world population of the middle of 22nd century which is in the stabilized

period, is close to that number.

According to Cohen, there are 67 cases where the supporting resources of the earth were figured in the past. Considering these studies, the smallest number is 1 billion, and the largest number was 1000 billion. The largest number is as 1000 times as larger than the smallest one and its range is quite wide. There are various methods of projecting, but the most popular method among them is to first, calculate the maximum quantity of food the world can produce, and then divide that number by quantity of food necessary for a person. Another method among them is to obtain the number by figuring out how much fresh water, instead of food, can be obtained. According to Cohen, among 67 projections, many numbers are centered around between 4 billion and 16 billion, and the average of the projected value within this range is 12 billion. This figure is even closer to those population projections, previously mentioned made by U.N. and Bank of World. By considering above all, it can be said that index of population carrying capacity of the earth is approximately 12 billion.

There is no more room to discuss further about the carrying capacity of the earth here, but one thing can be surely said, that is at the present stage, no definite answer for supporting power of the earth can be given. Two factors come up for the reason. The first factor is, we cannot anticipate how far scientific technology will progress into the 22nd century. "The Limits to Growth" (1972), a famous publication by the Club of Rome, gave the warning that the mankind will be destroyed because of destruction of the earth environment before a food shortage crisis hits. However in the book, scientific technology is mainly considered as bad, which only amplifies environmental pollution when coupled with manufacturing and agriculture production. By the way, Ehrlich's (Paul R. Ehrlich) well- known formula I=PAT, that is the impact for environmental destruction, is assumed as a multiplicative product of P(population), A(affluence), and T(technology), and here again technology is considered as only bad.

However, scientific technology is not necessiarily all bad. It has a lot of

good sides as well. For example technologies which repress the impact of environmental disruption and technologies to purify the environment. Technologies such as cultivating green water weeds to generate oxygen or to plant trees in the dessert are some of the examples. It is still unknown exactly how well these good technologies will develop in the future to prevent environment disruption. Nevertheless, it can be said that they have some room to change the figure of supporting capacity of the earth, depending on how technological innovation is materialized.

The second factor is that the supporting capacity of the earth can be changed by people's taste of various countries, cultures, religion, ideas, eating habits, consumption patterns, and life styles of the future.

If everybody on the earth wishes to eat a lot of meat, consume oil, live in a big house on a big lot like Americans today, it seems impossible for earth to support the previously mentioned 12 billion population. However, Indians may never eat beef, Japanese may refuse such a middle class American family's life style which is three people living on one acre lot, and may be satisfied with living in a small house like a rabbit house. People from all over the world may not necessarily agree that western material civilization, in which the American culture. represents as the most desirable one to seek after. A quite another type of value-system may be generated which involves a different life style, incorporating oriental philosophy.

6. Impact of the World Population Growth and Adjustment to it

Since Malthus, population growth has often been regarded negatively. Arguments in the 1950s and 1960s maintained that in developing countries, population growth would slow down development and prevent the rise in the standard of living. The argument is that population growth resulting from high birth rate would naturally bring a large youth population to raise and educate, causing an enormous economy burden which leaves no room for

economic growth. On the other hand, contrary to the argument, a new way of revised thinking, called revisionism has occurred recently in Europe and America. This points out that as long as population growth is not so severe, it does not have a dampening effect on economic development.

However, during last decade, it became clear that world population growth, especially population growth in developing regions, has had a bad influence on the environment of the earth. Particularly severe population growth in poor, developing regions is said to break up the balance of the life system on earth by abusing farm lands and expanding over its limit. After 1960, it was reported that in Africa, the dessert has been growing bigger, in South-East Asia and Central America, tropical rain forest are disappearing, moreover, in highlands such as the Himalayas, the Andes, and East Africa, mountainous regions are having been destroyed. It is a fact as many people have pointed out that at the bottom of this environmental disruption, there is a vicious cycle of population growth and poverty.

However, they say that fact is, up to this point, advanced industrial countries are the ones that have changed for the worse the earth environment. For example, carbon dioxide exhaust is causing the earth's temperature to raise and chlorofluoro-carbon gas is destroying the ozone layer. This is caused by mass production, mass consumption, and mass dumping.

The population of advanced industrial countries are only 1/4 of the world population, yet have consumed 3/4 of world resources by now. However, until now, mass production and consumption were considered a virtue, they were the symbol of economic development, rise of standard of living and prosperity. But the time has come that both developed and developing countries are pondering their goals of development and materialistic prosperity and are being urged to change immediately their paradigm and ideals. With this comes one of the new ways of thinking, development which can last, but internationally, they are not necessarily able to agree on how they should develop that which will last.

Environmental damage on a global scale up to this point, was caused by

the accumulated effect of mass production and consumption in advanced industrial countries and as mentioned earlier. It has become obvious that lately, damage tends to occur due to population pressure in developing countries from cultivating the agricultural land which should be left as is for expansion purposes of agricultural and stock farming. This seems to be true in most part, even though the media often tends to exaggerate their reports. It also must be true, that for developing countries, they don't want to listen to what advanced countries advocate. Because they barely started real development and they also want further development to raise their level of living, they are put in a confusien. The people in the developing world think that the demand from the more developed countries to slow down their economic growth in less developed countries, seems to be selfish and not accountable. It is difficult to see how this picture of a latent opposition between North and South can be dissolved.

World population problem, especially to reduce the population growth of developing countries by controlling birth rates, was the highest goal of all in the World Population Conference held in the past. In 1994 Cairo conference, as a trump, the idea of empowerment of women and reproductive health to solve the population problem was heavily advocated and emphasized.

Developing countries have experienced lowering birth rates by aggressively spreading family planning activities with the help of advanced countries. However, it is also true that a women's health and freedom to choose contraceptive devices was somewhat neglected, and simply for the purpose of meeting a national goal, enforcement and violation of human rights have took place in the past. The present policies of spreading family planning was reconsidered for its limits. In the 1994 International Population & Development Conference, they announced that ultimately it is more effective to approach this subject with a holistic view and wider scope rather than just as family planning, even if this seems to be a defour-marking method. That is the notion of what women's empowerment and reproductive health is all about.

7. Conclusion

Can world population problems be solved by approaching with a view of empowerment for women and reproductive health and rights? There is an example of Japan and Asia NIEs where they succeeded in lowering the birth rate in the past even though women's status was low. Comments are given that it is difficult to expect developing countries' birth rate drop rapidly only through empowerment for women. There are some opinions that distributing thinly the money for the social development of women from a small budget, just for favorable appearances, may be like throwing cold water on programs to spread family planning that have been effective with a rather small amount of money.

However, if no novel approach like reproductive health were given, or if no voices of NGO, which is adovocating feminism, were heard at the International population & Development Conference, the conference must have been a boring one and the world may not have shown this much interest as it does today over the population problem. It has become known that the approach which tries to spread family planning with a candy and whip, holding national goals at the front, without supportive development, has its limit. Maybe a fresh image, like reproductive health, and new concepts were necessary to change the anticipated standstill situation, which comes if things keep going

Table 1 World Population Prospects

Christian Era	Population (million)
0	300
100	310
1250	400
1500	500
1750	790
1800	980
1900	1,650
1930	2,070
1950	2,520
1975	4,080
1980	4,400
1990	5,280
1995	5,720
2000	6,160
2015	7,470
2025	8,290
2050	9,830
2100	11,190
2150	11,540

Source : United Nations. World Population Prospects. New York, 1994.; United Nations, Long-range World Population Projections, New York, 1992

Table 2 World Population Growth :
Past Estimates and Medium-variant Projections

Period	Annual increment (million)	Average annual growth rate
1950-1955	47	1.78
1955-1960	53	1.85
1960-1965	63	1.99
1965-1970	72	2.04
1970-1975	76	1.96
1975-1980	73	1.73
1985-1990	80	1.73
1985-1990	88	1.73
1990-1995	86	1.57
1995-2000	88	1.49
2000-2005	87	1.37
2005-2010	88	1.29
2010-2015	87	1.20
2015-2020	84	1.09
2020-2025	81	1.00
2025-2030	75	0.89
2030-2035	69	0.78
2035-2040	61	0.66
2040-2045	54	0.57
2045-2050	49	0.51

Source: same as table 1.

Table 3 Change of Total Fertility Rate for World, Less Developed and More Developed Regions Developed : 1950 - 2050

Period (yr.)	Total fertility rate			
	World	Developing regions	Developed regions	Difference of two regions
1950-1955	4.97	6.13	2.77	3.36
1955-1960	4.91	5.96	2.77	3.19
1960-1965	4.93	5.97	2.67	3.30
1965-1970	4.88	5.96	2.36	3.60
1970-1975	4.46	5.39	2.11	3.28
1975-1980	3.91	4.63	1.91	2.72
1980-1985	3.38	4.15	1.84	2.31
1985-1990	3.38	3.83	1.83	2.00
1990-1995	3.10	3.48	1.70	1.78
1995-2000	2.97	3.28	1.71	1.57
2000-2005	2.84	3.09	1.71	1.38
2005-2010	2.72	2.91	1.78	1.13
2010-2015	2.60	2.74	1.83	0.91
2015-2020	2.46	2.55	1.88	0.67
2020-2025	2.38	2.45	1.93	0.52
2025-2030	2.29	2.34	1.97	0.37
2030-2035	2.22	2.24	2.01	0.23
2035-2040	2.14	2.15	2.04	0.11
2040-2045	2.10	2.10	2.06	0.04
2045-2050	2.10	2.10	2.08	0.00

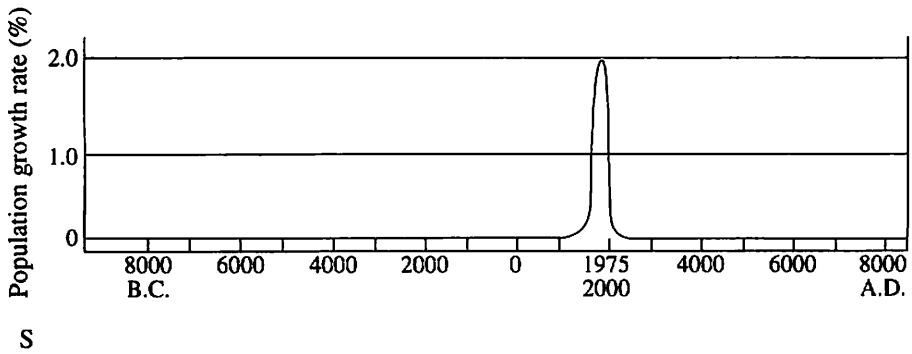
Source: same as table 1.
Note: Values are projected for periods of 1990 - 1995 and after.

Table 4 Estimated and Projected Population of the World, All Extensions, 1950-2150

Year	Medium	High	Medium/ High	Medium/ Low	Low	NRR dropped to 1.0	Constant fertility of 1990
1950	2516	2516	2516	2516	2516	2516	2516
1975	4079	4079	4079	4079	4079	4079	4079
1990	5292	5327	5327	5262	5262	5292	5311
2000	6261	6420	6420	6093	6093	5792	6463
2025	8504	9444	9444	7591	7591	7069	10978
2050	10019	12506	12495	7817	7813	7697	21161
2075	10841	15708	15328	7199	7082	7883	46261
2100	11186	19156	17592	6415	6009	8087	109405
2125	11390	23191	19358	5913	5071	8251	271138
2150	11543	28025	20772	5633	4299	8351	694213

Source: United Nations. Long-range World Population Projections, 1950-2150. New York, 1992.

Fig.1 Long-range Projections for World Population Growth Rate



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Chapter Three

The Change in the Industrial Structure in Asian Countries

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Introduction

East Asian countries, including those in the Association of South East Asian Nations (ASEAN), which have been blessed with favorable agricultural production conditions within the monsoon zone, have changed significantly in the last thirty years, but after 1990 they began to worry about the reduced percentage of self-supplied food. On the other hand, it is said that on an economic scale, soon they will account for one third of the world's economy, which would be on a par with America and the European Union. These economies have continued to grow miraculously in a sluggish world economy from the eighties through to the nineties, and although it shows a slowing of pace, compared to the seventies and early eighties, it is notable that growth of around five percent has been maintained throughout this whole region even in the early nineties.

This incredible growth was a simultaneous process of industrial structural change and the swift transferal from agricultural to manufacturing industries, the like of which has never before been experienced in the history of mankind. Most countries in this area, as developing nations, required financial support from the developed nations, however the Asian 'Newly Industrializing Economies' (NIE's) ended their reliance on financial support in the seventies, and Thailand and Malaysia of the ASEAN countries followed in the late eighties/nineties. The economic scale expanded throughout this whole area with the Indo-chinese countries including Laos, LLDC, joining ASEAN, but on the other hand the industrial structural change based on the movement from an agricultural to a manufacturing base continues towards the next century against a background of economic growth, although the variety of different levels of economic development and complications in its speed are seen. In this chapter, we would like to consider the realities, features and causes of change in the industrial structure. Although we can't make a comprehensive analysis due to incomplete data, as is typical of developing countries, I will try to cover this with additional information.

1. Change in the Industrial Structure from an Agricultural base to a Manufacturing base

Asia, especially the East Asian and Pacific region countries, has rapidly realized the conversion from an agricultural to a non-agricultural industrial structure in the last half century. In the 1950's, the agricultural percentage in all countries was much higher than that of manufacturing in the GDP composition ratio, except for Japan whose economic development had already moved ahead, and Hong Kong and Singapore who had 'City State' characteristics. The entire Asian region really had an agricultural status, as its agricultural share was two to three times greater than its manufacturing portion, and in China, Indonesia and India the agricultural ratio was high at around fifty percent.

If we define the point in time when the agricultural share falls below the manufacturing share as the conversion from one state to the other, Japan changed over first in the forties, Korea in the seventies, and the ASEAN countries in the eighties. Those common trends caused a declining agricultural base, which accelerated in the eighties, even though ASEAN countries were slower to change, and it is now about twenty percent.

As will be described later, the declining share of agriculture which includes the low-ranking working class could be due to the expansion of the service industry, including informal sectors, and not necessarily to an increased manufacturing share. That is the characteristic of the Asian region, but I shall not detail that here. When we look at the length of time it takes to change in the relationship of the share between agriculture and manufacturing, from the point in time where the agricultural ratio is ten percent above that of manufacturing, to the positions being reversed, in most countries it only took about twenty years, which is quicker than the Japanese pace of change (around thirty years), so the rate of conversion in the Asian region should be evaluated even though there are some differences from country to country.

Although it doesn't show in the tables, when we analyze the factors in the

structural change which are described by the absolute share change value in each industry, all countries, including ASEAN countries, show substantial change that is two to four times greater than Japan's. We must consider the characteristics when Japan entered a period of relative stability in the eighties. However, I think it is fair to say that it is a miraculous structural change which corresponds to the miraculous growth of the industrial structure in the Asian region, because it represents a greater change than that experienced by Japan at its peak.

In comparison to those who converted from agricultural to manufacturing bases, as regards the third industrial category which is the service economy, although Korea and Thailand had reached about 50% by the nineties, the ASEAN countries with the exception of Hong Kong, Singapore and Japan, had a comparatively low share of service industries (around 30-40%). (See Table 1)

2. The Increase in the Manufacturing Industry

Now we will look at the change in the industrial structure within the manufacturing industry, by considering the GDP composition ratio. The industrial development strategy of most developing countries, not only those in the Asian region, was basically the conversion from an import driven strategy in the sixties to an export driven strategy in the seventies. The material industry was the central important industry, and reacted to the needs of the initial stages of economic development including the completion of the infra-structure, but the scale of domestic market was relatively small and international competition was weak. Additionally, employment capacity is small as it is capital intensive, and the industrial strategy had to be changed for those reasons. An export industry strategy was adopted because of its international competitive edge, its employment capacity is greater, and technological transfer accompanied with capital investment from developed countries was comparatively easy through effective use of the plentiful and cheap labor force that existed in these countries.

The textile / clothing, agricultural food processing and machine equipment (as in manufacturing) industries became leading exporters. In the seventies, the food processing industry had the lion's share of the manufacturing industries within all ASEAN countries, and in the Philippines it was more than 40%, with three other countries having about a 20% share. Also, in Thailand, the Philippines and several other countries, the textile / clothing industry had a similar percentage share. (See Table 2)

Those industries which are comparatively intensive maintained their percentage share into the eighties, and the expanded share of the machine equipment industry became notable. Malaysia and Singapore showed remarkable growth and the share overtook that of the food processing industry. They are ambitious for economic growth and the fostered growth of the semi-conductor industry was a typical example, which expect the effect of technology transfer by positive attitude to the introduction of foreign capital. This is substantially influenced by the profits of a global marketing strategy of the developed industrial countries, including Japan, corresponding by chance with good timing.

3. Causes of Industrial Structural Change

Industrial structural change is, in a sense, a reflection of economic development, and also was made famous by the law of the classical scholar, Pety & Clark. Following much statistical analysis, it is said that as an historical rule, the weight of the economic structure shifts from the primary to the secondary industries, and then on to the tertiary industries in the search for efficiency. Recently, a theory of a forth, or perhaps a three point fifth , industry has been advanced with the softening of the economy.

Also, if the national income per capita doubles (from $250 to $500, or from $1,000 to $2,000) in the developing countries, including the Asian regions, it is estimated that the share of the primary industry would change by around

10% in the structural change as a result.

Regarding Asian countries per capita income (as defined by GNP), in the Philippines and India, who have been sluggish in the long-term, it has doubled within the last twenty years, but in other countries it has doubled within ten years, and even five years at the peak in several cases, although there is some variance in timing. On the other hand, as we have seen already, in many cases the structural change shows about 10% reduction in the share of the primary industries within ten years. Chart 1 shows the relationship between both trends. Because the differences between each country are quite pronounced considering the numbers involved, it can only be a rough measurement, but it seems to show a slightly larger structural change than the trend of all developing countries, which show a 10% reduction in the agricultural base with a doubling of income as previously described. (See Chart 1)

Let us now consider the expansion of the manufacturing share, and the relationship between economic growth and increasing production in manufacturing. This is a comparison of the ratios of manufacturing production increases against economic growth, which in other words is a measure of the elasticity value of economic growth in manufacturing production. A high elasticity value indicates an increase in demand of the economic growth which ensures the possibility of maintaining that growth by means of increasing demand on financial investment necessary for example by increased investment.

As Table 4 shows, the elasticity value in Japan and Singapore, whose economies are mature, was only a little above one throughout the seventies and eighties, but in Malaysia and Indonesia, who are in the early stages of development, the value is well above two, and it is also above one in Thailand, but the Philippines are not in the same situation.

The percentage increase of the mining and manufacturing industries which is higher than the GDP percentage increase, as above, has continued the industrial structural change which has increased the share of the mining and manufacturing industries as a result. However, we can't deny that the elasticity value has decreased across all countries and the tempo of the structural change slowed in

the eighties.

Lets us examine the industrial structural change with consideration of the economic activity to seek out efficiency after confirmation of the above situation. We define the 'comparative productivity' as being the 'structural ratio of the production value (separated by industry)' divided by the 'structural ratio of the number of workers (separated by industry)', and the productivity of that industry is equal to the productivity of all industries if the value is one, and the industry has economic profitability if the value is above one.

There is a common tendency in all countries for the comparative productivity to be less than one in the primary industries, and more than one in the secondary industries. The tendency of the primary industries in Japan is a long-term decline from a little less than 0.5 in the sixties to 0.36 in the nineties, and the secondary industries is also in a long-term decline from 1.35 in the sixties, to a little under one (0.97) in the nineties. As both the primary and secondary industries are less than one, it indicates that only the tertiary industries are above one, it can be said that it is a reflection of a shift to a service economy when the promotion stage is reached through industrial profitability. (See Table 5)

Although this common tendency of the comparative productivity of the primary industry being less than one and of the secondary industry being more than one was the reason for promoting change from an agricultural to a manufacturing base throughout the region, we can also say that the bigger the gap, the quicker the conversion speed. This strongly corresponds to the tendency that Thailand, Malaysia and Korea have.

However, in those countries where the comparative productivity in the nineties of the secondary industries are still more than one suggests the possibility of continuous industrial structural change, through the expansion of the share of the secondary industries as well.

A low comparative productivity indicates a high level of under employment in that industrial area, which means a labor intensive production structure. These potential over-populations mean there is a work-force supply base for non-

agricultural sectors in the long-term, though in reality, they are a low-income/ poor sector.

During the sixties and seventies, all ASEAN countries jointly promoted owner-farmers in the agricultural areas, in Indonesia and the Philippines who already had a high agricultural share, the percentage of owner-farmers was raised by around 10% within ten years, and Thailand showed the same trend. The support for agriculture was an important political issue as significant non-agricultural development wasn't expected at that time. However, the expansion of the economic scale wasn't noticeable and the introduction of foreign capital which was increasing at that time was mainly in manufacturing, and there were not enough conditions to increase agricultural efficiency. As a result, farmers relied on non-agricultural income and according to the planning data from Malaysia, the poverty ratio in rural areas was continuously three times greater than in urban areas. Although the degree of man-power surplus was gradually eased by the shift to manufacturing in the rural areas, it is a long way from achieving equity between agriculture and manufacturing.

4. Influence of Trade on Industrial Structural Change

We must note the role played by trade in the rapid development of manufacturing in the industrial structure. The percentage of manufacturing trade in all ASEAN countries was zero except 2% in Malaysia in 1970. However, it rose to 38% in Malaysia and around 20% in the Philippines and Thailand by 1992, and closely follows the Asian NIE's. (See Table 6)

It goes without saying that the percentage of primary industries in the export structure of all ASEAN countries was high in the seventies, and was still high in the eighties with an average of around 70%, reaching a peak of 94% in Indonesia, and had a strong resource export characteristic.

The causes of the significant change in the industrial and export structure are what the developed countries, including Japan, defined as the change to a

manufacturing base of ASEAN countries within the world trade strategy. The trade percentage of Asian countries with America, which is the world's biggest market, was less than 20% in the early seventies, and there was a trade deficit. The trade share with America suddenly exploded from 23% in 1980 to 47% in 1982.

In the sixties, the percentage of manufacturing exports was not notable, and even if we look at the percentage of manufacturing in domestic industry, it was also less than 20%. However, the rapid increase of direct investment from developed countries following the change to policies of accepting foreign capital by ASEAN countries who were promoting that investment were crucial for the rapid shift to manufacturing.

As regards the rate of change to manufacturing, even Malaysia, who was the first off the blocks, had investment restrictions on foreign capital guidelines in 1974. In 1985, the investment ratio restrictions on foreign capital for exports were eased, and in 1993 100% of foreign capital investment was authorized for companies whose business was more than 80% export. Also, Thailand took such measures as authorizing 100% of foreign capital for companies whose business was more than 80% export in 1992, following the establishment of a new Foreign Capital Law in 1988. Indonesia took similar action in the nineties as well, and China tried to react positively by establishing a special economic zone in 1979 and joint management was authorized etc.

Direct investment into ASEAN, for example from Japan, showed a substantial increase such as more than ten times greater in Thailand and six times greater in Malaysia in the eighties, because the ASEAN countries positively accepted the foreign capital. Although the standard is low, the growth rate is high, and total direct investment of NIE's became higher than the level of investment of Japan in all ASEAN countries except Thailand in the nineties.

The rapid change to manufacturing in the Asian region was strongly promoted by the international economic environment, but at the same time it is true that it was supported by internal demand following the expansion of the domestic market of each country as shown by the rapid rise in GNP per capita.

The expansion of a durable goods market and its increase in popularity, as typically shown in the rapid development of motorization is the result. Japan expanded its domestic market by shifting its major export products from textiles to domestic electrical goods, and enabling a decrease in the sales price by cost reduction through mass-production during the fifties and sixties. We can say that ASEAN countries adopted the same process during the eighties and nineties.

5. Advancing the Industry and Labor Force

Although investment is important to change of industrial structure, and to convert from an agricultural to a manufacturing base, the laborforce plays a large role, in other words labor movement is a reality. The results are shown in the change in employment structure. In Japan, the proportion of agricultural laborers shows a marked change, falling from 33% in 1960 to only 7.6% in 1990, which is less than a quarter, and Thailand, Malaysia and the Philippines also show a large change by halving in the same period. (See Table 5)

Within the employment structure change, as long as the agricultural production increases, absolute reduction in total agricultural workers cannot happen. All countries except Thailand continued to increase, although the percentage increases are less than one percent since the eighties. That is because the non-agricultural sector does not absorb the entire increase in population and laborforce. However, it is a fact that cannot be ignored that agricultural laborers don't settle.

When we look at the percentage population movement between rural and urban areas, the percentage that move from the countryside to the city tends to decrease in the long-term, for example in Japan, it has fallen from 36.8% in 1960 to 20.8% in 1984, a 60% decrease in percentage, and the flow the other way from city to country-side is slowly increasing from 14.9% to 22.2% in the same period. Although agricultural areas supplied work-force to non-agricultural areas by 20% net movement in the sixties which contributed to the conversion

from an agricultural to a manufacturing base, it can be seen that movement has virtually stopped in the nineties.

Compared to this, in Korea and Thailand, although the trend of movement percentage is similar, it can be seen that a net movement from farming villages to cities still continues in the nineties, and in Thailand the percentage is not always decreasing. Despite the inadequacy of the data, other ASEAN countries are considered to have a similar movement situation, by looking at the speed of change from an agricultural to manufacturing base.

The population movement was considered as above, regarding the reason for the movement in Korea 47% are for work, 30% in Thailand are to seek or change employment, it cannot be denied that it is characteristic of a labor force movement.

The differences between agricultural and non-agricultural income is quite significant, which can be deduced from the gap in the comparative productivity's of industries as previously seen, so movements from farming areas to cities cause pressures that cannot be considered small. It can't be denied that the agricultural sector has a labor force supply base character for non-agricultural sectors. (See Table 8)

It has been noted that each domestic condition regarding the movement of the laborforce contributes to the industrial structure change. Let us also quickly consider cross-border movements within the Asian region. Firstly, of those countries which are promoting most outward movement, Indonesia has been trying to react positively with a domestic movement plan to counter the overpopulation of Java, the main island, although it has many other islands. They have also been encouraging expatriation as part of this plan. After 1980, it increased and even after 1990 it is less than one percent of the domestic laborforce, at around 100,000 people annually, it is not so small compared to the population increase percentage (2.4% from 1980-92). The country which receives the most inward movement is mainly Saudi Arabia, but Malaysia and Singapore are above 20%, and those countries play the role of absorbing the insufficient un-skilled laborforce. In comparison, the over-demand of the

domestic labor force has stopped the expatriate flow from Thailand and Malaysia since the late eighties.

Japan is the country which now receives the largest number of foreign workers in the Asian region, though as a general rule, it refuses manual workers out of consideration for its domestic circumstances, and takes a role of talent development through acceptance of training of technical work-force and long-term overseas students. Accepting trainees corresponds to the realistic needs for development of expanding companies, it is not only for expert skills but we can say that it contributes to the technology transferal and industrial modernization.

The industrial structural change is the shift from agricultural to non-agricultural sectors, especially the manufacturing industry, within which there is a movement from labor-intensive to capital-intensive industry, in other words it has a highly advanced and modern industry characteristic. This advancing industry is based on a shift from labor to capital. However, demand at the advanced stage is for increased quality as regards the laborforce, which is the main factor in production. At the economic development stage it gradually became clear that there was insufficient skilled labor to cope with the demands of technology. Recently, in Asian countries, it appears that the human resource development policy is an important political issue equivalent to the infra-structure adjustment as a necessary condition for economic development. Insight into the supply of a work-force for the continuous economic development plan of each country has been presented with emphasis on the quality of labour.

Let us consider the process of industrial structural change in this area relative to the quality as seen before.

The population percentage increase is comparatively high in East Asia and the whole Pacific region, although it is falling from 1.9% in the seventies, to 1.6% in the eighties, and it is forecast to be 1.2% in the nineties. According to the results of the last twenty years, it is said that a decrease of one percentage point in the population increase rate from 3% to 2% is roughly corresponded to a 3% increase in the GNP per capita from 3% to 6%, so the fact can't be denied

that increases in the population place a burden on the economic standards. These are the background circumstances to positively tackling the population control by family planning in this area which had a population explosion in the sixties.

Total Fertility Ratis (TFR) in ASEAN countries fell significantly from around five people in the sixties to about two people in the nineties, except for Malaysia and the Philippines. These results are related to the gradual decline in the above population increase rate.

However, previous population increases had an time-delayed impact on the economic development. The rate of population increase after the seventies overtook the work-force population increase rate as we have seen. Work-force population increase rate has been about 0.5% higher than the general population increase rate such as 2.4% in the seventies, 2.1% in the eighties and 1.8% in the nineties. This result caused a reduction in the dependency population index (dependency population index = [youth + old-aged] / [production age population]), and it reduced the burden on current economic development.

On the other hand, when we look at the work-force quality, the increase in the laborforce population which mostly relies on the youth layers, significantly contributes to industrial modernization. Regarding the recent percentage of school attendance of the youth layer, without exception in the region, the fact can't be denied that the reality of dropping-out increases the percentage of school attendance in the junior high and high school level (the percentage of school attendance exceeds 100%), it is clear that the total educational background structure is being raised. (See Table 9)

With regard to the high level specialized universities, in Indonesia less than 1% attended in the seventies, but it rose significantly to 2% by 1990. Also, if we look at the example of Taiwan, NIE's, who had a ten year level gap compared to ASEAN countries in the raising of their industrial structure, university and junior colleges were already attended by ten percent by 1980.

As regards the economic effect of the raising of the laborforce quality as above, it is said that an increase of three years in the average length of time attending school (change from mainly lower secondary school level to high

school level education) corresponds roughly to a 4% increase in the GNP per capita, as shown by the macrotic results of the last twenty years. This suggests that the profit on educational investment is not insignificant. The percentage of financial investment in education is increasing in all countries throughout this region except the Philippines, with the highest being 23% in Korea, and even in the Philippines it was 10% after 1990. (See Table 9)

These standard education levels which we have seen do not always show remarkable economic effects in the short-term. Those circumstances caused a continuous demand on an insufficiently large skilled laborforce by companies/ industries. All kinds of private vocational colleges and professional educational institutes were established in addition to expanding the government run vocational training centers to cope with the demand. Japan has also suggested support for establishing and expanding vocational training institutes, when President Suzuki visited ASEAN countries. In Malaysia, the Philippines and Indonesia, the number of trainers in the government run vocational training institutes has more than doubled within the 1980's, and as 60% of all workers in the machine industry and over 20% in the electrical appliances industry are advanced technical workers, the trend of manufacturing technology as important has been strengthened.

In reality, human resource development and technological training in ASEAN countries cannot cope with all the needs due to the relationship of those small size companies. The scale of 90% of those companies within the ASEAN countries, except for Thailand, are mostly small with less than ten staff, so there is a limit to the amount the companies can invest in training. In these circumstances, it can be said that advanced foreign capital companies have contributed significantly with vocational training. Furthermore, hiring and retaining lower and mid-level auditing staff is a pressing need to enforce localization of human resources for advanced Japanese companies, and acceptance of trainees has increased significantly from 29,000 people in 1989 to 43,000 in 1993.

Conclusion

The rapid industrial structural change in the Asian region is another side to the rapid economic development and it may continue until economic development and growth decline. However, industrial structural change needs to react to the laborforce quality, if this condition is not adhered to, it may cause a problem that influences the economic development. That period is not likely to be faced soon, but remains a long-term important issue.

Table 1 Change of Industrial Structure (GNP composition ratio)

		1950-60	60-70	70-81	90	93
Japan	Agriculture	12.8	8.6	5.4	2.6	2.0
	Manufacturing	34.3	34.5	32.0	31.3	30.9
	Service Industry	52.9	56.9	62.6	66.1	67.1
Korea	Agriculture	39.2	32.0	20.3	9.8	7.0
	Manufacturing	13.1	19.0	27.0	32.9	43.0
	Service Industry	47.7	49.0	52.7	65.3	50.0
Malaysia	Agriculture	36.0	32.1	26.9	20.1	17.0
	Manufacturing	8.7	10.8	19.2	31.2	44.0
	Service Industry	55.3	57.1	53.9	48.7	39.0
China	Agriculture	52.2	40.4	38.3	28.3	20.9
	Manufacturing	23.9	40.9	44.9	43.6	51.7
	Service Industry	23.9	18.7	16.8	27.1	27.4
Thailand	Agriculture	39.8	33.6	30.3	14.7	10.0
	Manufacturing	12.6	14.7	17.9	31.3	39.0
	Service Industry	47.6	51.7	51.8	54.0	51.0
Philippines	Agriculture	25.7	26.7	25.9	23.8	22.0
	Manufacturing	20.3	20.8	24.6	27.0	33.1
	Service Industry	54.0	52.5	49.5	49.2	44.9
Indonesia	Agriculture	50.0	49.5	34.2	28.0	19.1
	Manufacturing	8.4	8.5	19.1	29.1	39.2
	Service Industry	41.6	42.0	46.7	42.9	41.7
Singapore	Agriculture	3.5	2.9	2.0	0.3	0.0
	Manufacturing	11.6	16.3	23.3	32.1	37.0
	Service Industry	84.9	70.8	74.7	67.7	63.0
Hongkong	Agriculture	3.4	2.6	1.3	0.1	0.0
	Manufacturing	15.5	30.9	27.4	25.5	21.0
	Service Industry	81.1	66.5	71.3	74.4	79.0
Laos	Agriculture			61.9	59.1	
	Manufacturing			17.7	16.3	
	Service Industry			21.4	24.7	
India	Agriculture	48.9	48.2	40.6	31.2	31.0
	Manufacturing	15.5	14.4	16.3	29.1	27.0
	Service Industry	36.5	37.4	43.1	39.7	42.0

Source: World Bank and Others

Table 2 Change in Composition by Manufacturing Industry (%)

		Agricultural Food Processing Industry	Textiles/Clothing Industry	Machinery Equipment Industry	Others
Thailand	1960				
	70	32	21	6	
	84	23	20	12	
Malaysia	1960				
	70	27	4	16	
	84	18	6	28	
Indonesia	1960				
	70	18	7	5	
	84	20	7	7	
Philippines	1960	40	10	7	
	70	40	10	7	
	84	42	11	9	
Singapore	1960	14	3	12	
	70	42	11	9	
	84	44	14	8	
Laos	1980	28	21	20	
	85	25	12	19	
	90	26	8	12	

World Bank and other National Annual Statistical Reports

Table 3 Change in GNP (US$) per Capita

	1976	1980	1985	1990	1994	(1994/1976)Ratio
Japan	4,676	9,068	9,352	23,801	37,618	8.0
Korea	797	1,592	2,242	5,883	8,483	10.6
Malaysia	950	1,800	1,910	2,400	3,140	3.3
China	375	456	814	1,559	2,663	7.1
Thailand	430	720	810	1,530	2,110	4.9
Philippines	410	690	520	750	850	2.1
Indonesia	270	490	520	570	740	2.8
Laos				200	280	
India	170	250	280	370	300	1.7

World Bank 1995

Chart 1 Economic Levels and Industrial Structure (Agricultural Share)

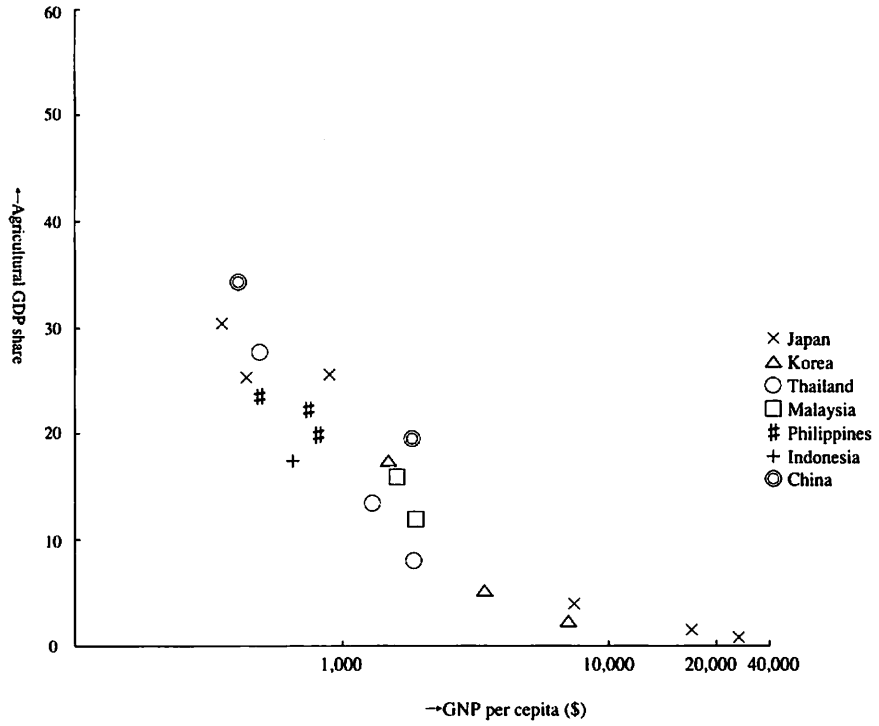

Table 4 Percentage Increase in GDP and Mining and Manufacturing Industries

	GDP		Mining and Manufacturing Industry	
	1970-80	1980-92	1970-80	1980-92
Japan	4.3	4.1	4.7	5.8
Korea	9.6	9.4	17.0	11.9
China	—	9.1	—	11.1
Thailand	7.1	8.2	10.5	10.1
Malaysia	7.9	5.9	20.5	10.0
Indonesia	7.2	5.7	14.0	12.0
Philippines	6.0	1.2	6.1	0.7
Singapore	8.3	6.7	9.7	7.1
India	3.1	5.7	4.1	5.7

World Bank and other National Statistics

Table 5 Change in Comparative Productivity by Industries

		1960	65	70	75	80	85	90
Japan	Primary Industry	0.49	0.48	0.34	0.42	0.39	0.37	0.36
	Secondary Industry	1.35	1.15	1.21	1.04	1.13	1.19	0.97
Korea	Primary Industry				0.60		0.56	0.54
	Secondary Industry				1.36		1.35	1.19
Thailand	Primary Industry	0.47			0.43			0.24
	Secondary Industry	2.06			1.62			2.67
Malaysia	Primary Industry	0.57				0.66		0.53
	Secondary Industry	0.83				1.01		1.51
Indonesia	Primary Industry							
	Secondary Industry							
Philippines	Primary Industry	0.35				0.49		
	Secondary Industry	1.86				1.34		

Note: Comparison Productivity = Structural Value of the Production Cost [separated by industry] ÷ Structural Ratio of the Number of Workers [separated by industry]

Table 6 Manufacturing Export Percentage (%)

	1970	1992
Japan	41	67
Korea	7	40
China	15	15
Thailand	0	22
Malaysia	2	38
Indonesia	0	4
Philippines	0	17
Hong Kong	12	24
Singapore	11	52

World Bank 1994

Note: Manufacturing Percentage = Machine Export value / Total Export value\

Table 7 Change in Proportion of Work-force Structure by Industry

		Agriculture	Manufacturing Industry
Japan	1950	48.7	26.3
	60	33.0	41.0
	90	7.6	33.6
Korea	1960	66.5	11.6
	70	49.1	33.4
	3	29.7	
China	1970	78.3	Ål
	81	72.0	18.2
Thailand	1947	85.8	3.1
	60	84.0	9.0
	83	70.8	12.3
	90	58.9	11.7
Malaysia	1947	67.5	13.9
	60	63.0	12.1
	83	27.3	22.2
	90	26.3	20.5
Indonesia	1961	73.3	10.2
	80	56.3	16.1
Philippines	1948	72.2	10.9
	60	61.0	15.0
	83	52.1	18.3

ILO Yearbook of habor Statistical Report etc.

Table 8 Movement percentage from Countryside to City (%)

		Village to City	City to Village
Japan	1960	36.8	14.9
	70	29.5	19.8
	80	23.0	22.7
	90	23.5	21.2
	94	20.8	22.2
Korea	1966 ~ 70	50.2	10.7
	71 ~ 75	40.8	14.2
	76 ~ 80	43.9	12.9
	81 ~ 85	35.5	14.5
Thailand	1965 ~ 70	12.4	6.1
	75 ~ 80	15.8	10.1
	85 ~ 90	20.8	15.1
China	1982 ~ 87	50.6	6.2
India	1971	16.2	8.7
	1981	19.8	8.8

Source: Population Movement in Japan - Fluctuation in Population Distribution by Area and Movement between Areas since the War' by Atsushi Otomo) ESCAP, Asian Population Studies Series No. 138, No. 89

Table 9 Change in the Percentage of School Attendance (%)

	Elementary School			Junior High School			High School		
	1960	70	91	1960	70	91	1960	70	91
Korea	94	107	97	27	63	98	6	17	25
China	109	89	123	21	24	51	Åİ	1	2
Thailand	83	83	113	13	17	33	2	13	16
Malaysia	96	87	93	19	34	58	2	4	7
Philippines	95	108	110	26	46	74	19	28	28
Indonesia	71	80	116	6	16	45	1	4	10

World Bank Report 1994 etc.

Table 10 Number of Newly Admitted Foreign Trainees in Japan

	1989	1993
Total	29,489	43,627
Asia Total	22,723	38,431
China	3,496	15,054
Thailand	4,502	5,385
Philippines	3,974	3,931
Korea	4,125	3,717
Indonesia	1,748	3,687
Malaysia	2,175	2,959

Immigration Control Institute: 'Immigration/Emigration Control Statistics'

Chapter Four

Agricultural Conditions in Asian Countries

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1. South East Asia

1) Economic Development and the Incidence of Agricultural Problems

In the South East Asian region, with the exception of the Philippines, all ASEAN countries have achieved continuous economic growth during the last quarter century. When the per capita income growth rate is considered, the last decade (1985-94) has seen Thailand, Indonesia and Malaysia record the high economic growth rate at 8.6%, 6.0% and 5.6% respectively. In comparison to the high economic growth rate of the other ASEAN countries, the Philippines is the exception at only 1.7%.

Per capita national income levels in 1994 were US$880 in Indonesia, US$ that of in Thailand and US$3,480 in Malaysia as a result of this high economic growth, but it struggled to reach approximately US$950 in the Philippines. If we consider the estimated value of the purchasing power parity standard to compare the relative standards of life, we see that the cost for non-traded goods is fairly low for developing countries, and we get figures of US$3,600 for Indonesia, US$6,260 for Thailand and US$7,050 for Malaysia, but only US$2,740 for the Philippines, which is slightly less than the Indonesian figure.

The ratio of agricultural production out of the gross domestic product has fallen significantly in these ASEAN countries, and becomes now very similar to that of the developed countries (Table 1). It can be said that these ASEAN countries are no longer agricultural countries.

The agricultural portion in the national economy is larger in Vietnam where the shift to a market economy has only recently begun with the introduction of the Doi Moi policy. South East Asian countries other than Vietnam, Myanmar, Cambodia and Laos are no longer deemed to be agricultural countries.

Foodgrain production has not shown a rapid decrease in these South East

Asian countries, although the ratio of agricultural production out of the gross domestic product has been falling. The net export ratio of 'Foods and Animals' which is defined as '0' by the Standard International Trade Classification (SITC) for 1980 and 1993 is calculated as a measure which indicates international competitiveness regarding foodgrain production. This net export ratio is often used as a measure to indicate commodity export competitiveness which is an international trade topic, and is calculated as the trade imbalance divided by the trade sum. i.e. [export value - import value] / [export value + import value]. It is seen that Vietnam, who only recently returned to the international economic sphere through Doi Moi policy, increased their export competitiveness most rapidly in this area. On the other hand, the Philippines, who are worried about a sluggish economy, decreased their export competitiveness rapidly in this area as well. Within ASEAN countries, it indicates that Thailand still maintains a strong international competitiveness, and also international competitive power has not decreased, following the efforts made for domestic food production, in Malaysia and Indonesia.

However, attention must be paid to the fact that the conversion of the employment structure is somewhat slower than the decrease in the agricultural ratio of the gross domestic product in those ASEAN countries who have enjoyed continuous high economic growth. The ratio of agricultural workers out of the total number of workers is still around 50% except in Malaysia, whereas the ratio of agricultural production within gross domestic product has decreased to less than 20% in ASEAN countries (Table 1).

Let's take the case of Thailand as an example. The ratios of manufacturing industry and agriculture within the gross domestic product switched over when both levels were just above 20% in the early eighties. The ratio of manufacturing industries continued to grow, reaching a level of just below 30% in 1993, in contrast to the agricultural ratio which continued to fall and reached 10% in the same year. Reallocation of labor between these industries has lagged far behind compared to the conversion in production, with the ratio for manufacturing industry being only 13%, in contrast to the 58% for agriculture, in 1993. At the

start of the eighties, the ratio of agricultural workers was just above 60%, while it was approximately 10% in the manufacturing industry, although the production ratios of both agricultural and manufacturing industry were at almost the same level.

The delay in the conversion of the employment structure has some significance, that the productivity differential per labor is expanding between agricultural and manufacturing industries. The productivity of six agricultural workers was equivalent to that of one in the manufacturing industry when the production ratio of agriculture and manufacturing industry in Thailand was equal in the early eighties. Thus the labor productivity was 1:6 between these industries. By 1993 however, it had become 1:11, indicating that the difference in labor productivity between agricultural and manufacturing industry had been expanding during the economic growth from the eighties onwards. Other countries in Asia have also seen an expansion in the difference between the labor productivity per labor in the agricultural and manufacturing industries during their economic growth in exactly the same way as Thailand.

This imbalance in the labor market is seen as part of the process of economic growth. Rapid technological progress can be seen in manufacturing industries, which increases labor productivity. Although agricultural labor productivity has also been increasing quite quickly within Asian countries, it is rather slower than that experienced in manufacturing industry. The rate of the agricultural labor productivity increase is always lower than that of manufacturing industry, because technical progress is delayed in the agriculture by its existing surplus labor problem.

The agricultural problem has become notable because of the results of the economic growth in ASEAN countries almost exactly the same as those experienced by developed countries. Perhaps we can say that this is the most important issue within the agricultural conditions in ASEAN countries.

2) Variety of Agricultural Development in South East Asia

The economic growth rate of the agriculture is not so low although its

importance within the national economy is declining. If we consider the actual economic growth rate in the agriculture, we find that in Indonesia it was 3.4% from 1980 to 1990, and 3.0% from 1990-94, 4.0% and 3.1% in Thailand, and 3.8% and 2.8% in Malaysia, during the same periods. These rates are not so low. However, the rate of 1.0% and 1.6% in the Philippines is again exceptional within the ASEAN countries, but is the same as the macro economic growth trend.

The fact which needs to be considered is that agricultural development patterns within ASEAN countries are not the same. The individual agricultural development patterns relate to the history of each country. The difference in agricultural development patterns between Indonesia and Thailand will be looked at.

In Java, which is the core area of Indonesia, there is a long standing tradition of small scale family agriculture which makes intensive use of the land for paddy field *sawah* and homestead land *pekalongan* on fertile soil blessed with plenty of water resources created by the ecological conditions prevalent in volcanic islands situated in the tropics. A densely populated and closed agricultural society has been created throughout the long history.

Absorbing surplus population into non agricultural activities is considered the main development point in this kind of populous closed areas. However, the risk of the 'Ricardian trap' is high in the development of these areas. Thus, technical innovation and agricultural development are necessary to improve land productivity whose resources are decreasing.

Basically, productivity per agricultural worker must be increased if agricultural development is to be part of the economic development. The average labor productivity per worker is described as a product of the land productivity and the agricultural area per worker. It is quite obvious that labor productivity can only be increased by raising the land productivity, as it is impossible to expand the available land area in densely populated societies. A tidal wave of agricultural development, popularly known as the 'green revolution', was seen in many Asian countries from the seventies onwards. This was the movement

which introduced new varieties for cultivation that could possibly increase the yield, and became popular for foodgrains, such as rice and wheat. New varieties which were able to raise the yield were developed by the International Agricultural Experimental Research Institute. Whether these newly developed varieties of rice and wheat are actually cultivated or not by farmers rather depended on the conditions, which were the completion of irrigation systems for agricultural use, and the possibility to obtain sufficient volumes of fertilizer at a reasonable cost. The green revolution succeeded in countries or areas where these conditions were broadly met.

Incidentally, it is said that rural Java is one such example of a green revolution success, because the character of these closed farming villages strongly affected this agricultural development process. The BIMAS project was a government led initiative from the late sixties onwards, for increasing rice production, based in Java. The government's role in repairs and development of the irrigation facilities was large, as well as investing enormous subsidies in fertilizers. Basically repairs and expansion of the irrigation systems made during the Dutch period was the major project, and it is a dual control system in which the main irrigation canal was controlled by a public sector, while the end of the canal was controlled by village itself. Responsibility for popularizing the cultivation of these new high yielding varieties was given to specially appointed officials in central and local government, who would have meetings with various farmers representatives, who in turn would pass on this new agricultural information to the other farmers in their villages.

Farmers in Java positively adopted the new technology based on these high yielding varieties as long as it was supported by subsidies and brought them economic profitability as well. The farmers in Java didn't hesitate to adopt them after they received information about this new technology and understood that their economic profitability was large, despite being entrenched in village customs. Individual farmers could act rationally as long as it did not conflict with the customs. Economic development in Indonesia avoided falling into the 'Ricardian trap' as the government led agricultural development

succeeded.

The farm village societies in the Chao Phraya Delta in Thailand, are completely different to those found in Java, which are typical 'outward-looking and open village societies'. The Chao Phraya Delta, which is an important area of Thailand, had been the last largest area of unused land in human history, but since the mid-nineteenth century it has been rapidly developed as suitable land for export rice production, and a frontier style of life in which people act freely has been established.

A fixed difference in income due to relative farming scales hardly existed because basically there was plenty of unused land available. It can be said that the farm village society which was created on the delta was an outward-looking and open village society, with no distinction between insiders and outsiders, formed by merchant who had strong connections with world markets. Economic development in Chao Phraya Delta was a typical example of a 'vent for surplus' type.

Recent annual agricultural developments in Chao Phraya Delta are based on agricultural diversification such as production of commercial crops rather than rice, led by city-based merchants, just the same as the period from the mid-nineteenth century. Prawn farming is a typical example. It has been developed using the water and canals originally prepared for rice cultivation, in the Langsit area, which since the mid nineteenth century had been the central area for rice growing in the delta. A poultry industry has also been developed through contracts with the city merchants of Chachengsao and Chol Buri, which are both located on the eastern side of the delta. These were typical examples of contract agriculture.

Such agricultural development in each area of the delta has been brought about through contact between the rice growing farmers and merchants who colleted the changing domestic and international informations. These merchant led agricultural developments were also in response to the varying food consumption within Thailand, and avoided the 'Ricardian trap' in the wider sense. Also it must be noted that the economic power of the delta farmers has

been significantly increased through this diversification, and the farming villages in Thailand have continued to supply a large and expanding domestic market for import substituting industry. Farmers purchase motor-bikes, televisions and refrigerators, which are considered the three luxury items within farm villages, and plenty of zinc sheeting for roofing the farm houses, polypropylene bags for rice and fertilizers and chemical condiments. As an increase in domestic consumption was necessary for industrialization, formers were also important consumers for this increasing private consumption in Thailand. Agricultural development has an important role as a supplier in an expanding market for domestic manufacturing industry by increasing the farmers' income as well as ensuring the food supply, which is emphasized by the argument known as the 'Ricardian trap' in the development of the national economy as a whole. It is necessary to emphasize that agricultural growth made a great contribution to domestic economic development through these processes in Thailand.

3) Reactions of each Country to the Liberalization of Trade in Agricultural Products.

Now, ASEAN countries are being pressed to tackle trade liberalization of agricultural products through joining the WTO, the formation of ASEAN free trade agreement and trade liberalization by APEC. Thus, each country's way of dealing with this will be summarized.

There are no difficult political problems that accompany agricultural trade liberalization in Thailand, which is the main agricultural exporter. However, the government adopted a policy which spent funds on subsidies for price stabilization of twelve agricultural products through the Farmer's Support Committee, as maintaining farmers income is a significant problem. At the same time, the Ministry of Agriculture is going to spend 65.9 billion bahts by 2010 to institute a plan to reorganize the agricultural production system based on the cabinet decision of 28th December, 1993. This is to strengthen agricultural productivity in Thailand, by changing from crops which are less profitable in the marketplace, such as rice, cassava, coffee and pepper, to those which are

more profitable.

In Indonesia, they decided to lay emphasis on the stabilization of the domestic market as well as the privatization of BULOG, in preparation for and to correspond with the tariffication of rice. They also consider a policy to correspond to AFTA by making a decision to decrease the duties on soya beans and corn which were important items for agricultural diversification. However, Indonesia insisted that important agricultural products such as rice should be treated as exceptional items within the trade liberalization at the recently held conference on AFTA (December 1995), and other ASEAN countries seemed to wonder whether Indonesia was really willing to tackle agricultural liberalization.

There are no significant problems regarding agricultural trade liberalization in Malaysia, who freely import grain products. They continue improving their rice production competitiveness by following the basic national agricultural policy, as decided in the mid-eighties.

In the Philippines, a ten year postponement measure was approved regarding the tariffication of rice as it was a developing country. Also, there is no need to reduce the current expenditure to maintain the market price of rice and corn as it does not exceed 10% (5% and 1% respectively of the production value). They removed the restrictions on the volume of corn imported, and protected it with higher custom's duties. Also, they decided to abolish other import volume restrictions on coffee, onions, garlic, potatoes, cabbages and meat products.

Table 1

	Thailand	Indonesia	Malaysia	Philippines	Vietnam
Economic Structure (1993)					
Agriculture	11.9%	18.4%	15.8%	21.7%	42.5%
Manufacturing Industry	28.3%	22.4%	30.1%	23.8%	27.9%
Employment Structure (1993)					
Agriculture	60.7%	52.0%	21.4%	15.8%	72.0%
Manufacturing Industry	11.1%	10.6%	24.0%	10.0%	10.7%
Rice Production per Capita (1993)	215kg	166kg	66kg	147kg	205kg
International Competitiveness Index of Foodgrains					
1980	0.82	0.00	Δ0.41	0.42	0.47**)
1993	0.65	0.35	Δ0.20	0.00	0.70***)
Engel Coefficient	33.6%	53.4%	39.1%	56.5%	

*) 1992
**) 1986
***) 1991

2. South Asia

1) Continuous Food Problems

The number of people living in poverty in South Asia is 520 million, the majority of whom are in India, while those suffering from malnutrition is 270 million, comprising 47% and 34% respectively of each category of the global population, and 51% and 24% of the total population in South Asia [1]. The only way to resolve this problem of hunger is to promote agricultural and rural development within the affected areas rather than redistribution of food, because basically hunger is caused by insufficient purchasing power, especially in South Asia where most of the population directly or indirectly make their living through agriculture.

The share of agriculture in South Asian economy is still high (Table 2). Although the GDP share has been falling rapidly to below 30% recently, 70 ~ 90% of the population are still living in rural areas, and also 50 ~ 60% of the labor force is employed in agriculture.

Agriculture can't be the engine of economic development in South Asia because it has scarce land resources. However, agricultural growth is one of the important basic conditions of economic development, and development strategies that have ignored agriculture have all failed, which can be seen throughout the history without recalling the failure of the heavy chemical industrialization in India in the mid-sixties. India has shifted to economic liberalization since 1991 and it has been supported by the consumption boom of the 'new middle class' up to now, but its continued success will largely depend on the agricultural performance. The Chinese experience may be an important lesson for South Asia as well, as it achieved rapid industrialization based on rural enterprises, on the basis of the fact that the agrarian reforms in the late seventies raised agricultural productivity and brought about an equitable and significant increase in rural income.

Under the disadvantages of increasing population pressure and

environmental degradation, agriculture in South Asia has the important and difficult task of creating the pre-conditions for overall economic development. It has to increase food production and reduce poverty and malnutrition.

2) Agricultural Growth

Food situations in South Asia has shown some improvements after the mid-seventies, in contrast to the stagnation in sub-Saharan Africa (Chart 1). The 'green revolution' which used to apply only to wheat, started to effect rice as shown in Table 3. The benefits of the technological innovation were felt in those most poverty stricken areas with the densest populations in eastern India and Bangladesh.

Irrigation is famous for the leading input for 'green revolution', and in South Asia it is impossible to talk about irrigation without 'private tubewells'. In Punjab, an advanced agricultural area, private tubewells were used to supplement water in government canal systems. They also made a great contribution towards popularizing the 'green revolution' technology in rice sector in eastern India. South Asian ecological conditions required a large scale canal irrigation networks compared with East Asia, which resulted in intolerable inefficiency and corruption [2]. Private tubewells supported their defective system, and were especially indispensable for growing rice which requires much water.

Private tubewells had mainly been installed by rich farmers. A 'water market' where groundwater was sold to poor farmers nearby had been developed in areas with small and fragmented fields such as exists in eastern India and Bangladesh. The 'water market' enabled poor farmers who couldn't invest in tubewells to adopt new rice technology.

However there were some problems. According to my research in Bangladesh, the water charge is about 33 ~ 40% of the gross revenue of crop production, and the internal rate of return for investment in tubewells is approximately 70% annually [3]. It can't be said 'exorbitant profit' because it is more or less the same level as that of the other investment opportunities in the

village, but neither can it be denied that an unfavorable effect on income distribution between tubewell owners and non-owners was created. Another problem of private tubewells is the detrimental effect on the environment, because unplanned pumping up of groundwater has been encouraged. Thus, the level of groundwater table is falling year by year, with serious effects, such as increased costs for raising water, and wells for drinking water drying up, being seen in some areas.

The most serious criticism relating to the 'green revolution' is that it has not been applied to the rainfed areas where water control is difficult. Seventy percent of land in India has no irrigation, and in these areas infrastructure, such as roads, markets, electricity supply, banks and schools, which strongly promote the diffusion of the 'green revolution', have been underdeveloped [4]. However, a strong opinion against these criticisms was recently presented. This opinion is that the priority of investment in research and development should not be shifted to unfavorable areas (coarse grains, root and tuber crops etc.) because the regional disparity is actually minimized by the adjustment of labor markets and the production adjustment suitable to each region [5]. However, I would like to present two points for further consideration. Firstly, adjustment of labor markets is hard because in many cases it is difficult for people to be transferred. Secondly, the mechanisms is not clear enough, in which economic activity (production/processing of non-rice crops or rural industry) emerges to support the region which has been bypassed by the 'green revolution'. The second point means the conflict of two hypotheses. One is that the 'green revolution', through its forward /backward linkages and final demand effects, create non-agricultural working opportunities within the area. The other is that the 'subsistence pressure' of the labor supply side is important for the creation of the non-agricultural working opportunities in the area [6].

Finally, I would like to mention about the relationship between the land tenure system and agricultural productivity. Where large-scale farms and/or tenants exist widely due to unequal distribution of land ownership, the issue is whether such land tenure system could be a factor in depressing the agricultural productivity

or not. The land lease market in South Asia works quite different with that in East Asia. In South Asia it is weak in redistributing land from inefficient to efficient operational farm sizes, thus inefficient large-scale farms and/or tenancy farms still widely exist (Table 4.) [7]. There is also a evidence in West Bengal that tenancy reforms stimulated the production incentives of tenants [8]. It could be said that if the land reform succeeds, it will have the effect of not only improving income distribution but also increasing productivity. In China the dissolution of the People's Commune, which led to the revival of family farm, stimulated the production incentives of the farmers. This is another evidence which shows how important an incentive system is for farmers. It cannot be said that land reform is not necessary in areas where 'feudalistic' large-scale farms and/or tenancy farms still widely exist, such as in Bihar in India or Sind in Pakistan, etc.

3) Policies to Reduce Poverty

So far the importance of an agricultural development strategy was emphasized and now we must emphasize a necessity for a policy which is targeted on landless, making up 40 ~ 50% of rural households in South Asia (Table 4.). This is because agricultural development gives more direct benefit to landowners than to landless workers. It relates to the policy emphasizing food entitlement, as defined by A.K. Sen [9].

Representatives of these policies are public food distribution system, labor intensive public works programme (wages are paid in wheat in 'Food for Works'), food distribution programme for students ('Food for Education') and low-interest finance for the promotion of self-employment. IRDP in India, and Grameen Bank in Bangladesh are well-known for such micro-credit system. The impacts of these credit schemes for the landless poor are well documented. Table 5 shows an example of the impacts of IRDP by SAM method, in which direct and indirect income generating effect can be evaluated [10]. Clearly IRDP has a big impact on landless laborers.

Through my survey experiences of rural credit market in Bangladesh, I

found that Grameen Bank doesn't always create the self-employment opportunity as per the original policy purpose, but also found at the same time that access to low-interest credit produces benefit in other forms. Many poor loanees spend the borrowed money from Grameen Bank on land pawning and become 'owner farmers'. This is the strategy for securing rice for consumption for them. In this case Grameen Bank plays a role to promote land reforms [11]. M. Hossain clarified in his research that the income of the loanees increased on an average 30% after three to four years of joining Grameen Bank [12].

If income of the landless poor is increased by some policy measures as noted above, it could be a chance to break the vicious circle of environmental deterioration and population growth as P. Dasgupta claimed [13]. Typical example is fuel. People relied on bio-mass resources as fuels in rural South Asia, but these resources are diminishing year by year very rapidly. Therefore, children will be expected to be a cheap labor force to collect fuel. Securing the fuel supply causes higher fertility and causes a population increase and environmental damage as a result. They cannot afford to educate their children in this situation. Dasgupta expects to break this vicious circle with such policy measures as the Grameen Bank.

4) Conclusions

Some important issues which can't be easily understood simply by the calculation between two variables, namely food and population, have been discussed in this paper. First of all, the opinion of emphasizing redistribution of food should be denied. The problem is difficult to be solved without an increase in food production in the very areas which suffer from hunger. We emphasize the importance to promote agricultural and rural development in the region which was bypassed by the 'green revolution', not to leave it to chance with assuming a predetermined harmonious adjustment mechanism, in which laborers can move to advanced villages (of course we cannot deny that such mechanism is actually working to some extent). The most effective means for that purpose is improving infrastructure such as irrigation, roads, markets,

electricity, banks and schools, in addition to promoting research and development for unfavorable regions (and crops). Secondly, if the increased productivity through the 'green revolution' causes an inequality in income distribution, the effect is halved, because hunger is rooted in insufficient purchasing power as mentioned in the beginning. Thus, in South Asia it may be important to establish a suitable system to develop and manage tubewells (it is also important from the point of view of sustainable use of groundwater). In addition, I would like to bring your attention to the point that land reform is still an important policy issue to be considered in some areas as the basis for growth with equity. Finally, policies targeted at rural poor should continue to be considered important, as well as the 'green revolution' strategy because it enables the side-effect of population control by raising the food entitlement of those impoverished people, and eases the environmental deterioration.

In this paper the agricultural marketing and pricing policies, issues of subsidies for agricultural input and agricultural taxation problems had to be left out because of the restriction of space. Please refer to other literature regarding these things[14].

Footnotes

(1) Data source is as follows. Populations below poverty is the estimates of the World Bank in 1985 ('World Development Report 1990'), Populations of malnutrition is the estimates of FAO in 1988/90 ('World Agriculture in 2010').

(2) Wade,R., "The Ecological Basis of Irrigation Institutions: East and South Asia", World Development, Vol.23, No.12, 1995.

(3) See K.Fijita, "Bangladesh: Changes in Villages by Shallow Tubewells" ('Irrigation Systems in Asia' edited by Horii, Shinoda, Tada, Shinpyoron, 1996).

(4) Binswanger,H.P. and others, "How Infrastructure and Financial Institutions

Affect Agricultural Output and Investment in India", Journal of Development Economics, 41, 1993; Ahmed,R. and M.Hossain, Developmental Impact of Rural Infrastructure in Bangladesh, IFPRI, 1990.

(5) David,C.C. and Otsuka,K., Modern Rice Technology and Income Distribution in Asia, IRRI, 1994.

(6) It is interpreted that the argument of Western European Proto-Industrialization is based on the latter hypothesis. ('The Era of Proto-Industrialization', Osamu Saito, Nihon Keizai Hyoron-sha, 1985.)

(7) Raj,K.N., "Mobilization of the Rural Economy and the Asian Experience", The State of Development Economics: Progress and Perspectives, Basil Blackwell, 1987. See also K.Fujita, Introductory Analysis of Bangladesh Agricultural Development, 1993, National Research Institute of Agricultural Economics.

(8) See K.Fujita, "A Note on Bengali Agricultural Development in the Eighties" ('Sustainable Development of Asian Agriculture : Intrusion of Market and Progress of Institutions and Organizations' edited by Hiromi Yamamoto, 1996, Institute of Developing Economies).

(9) Sen,A. and Dreze,J., The Political Economy of Hunger: Entitlement and Well-Being (Volume 1, 2, 3), University Press Limited, 1991.

(10) Parikh,A. and E.Thorbecke, "Impact of Rural Industrialization on Village Life and Economy: A Social Accounting Matrix Approach", Economic Development and Cultural Change, 45, 1996.

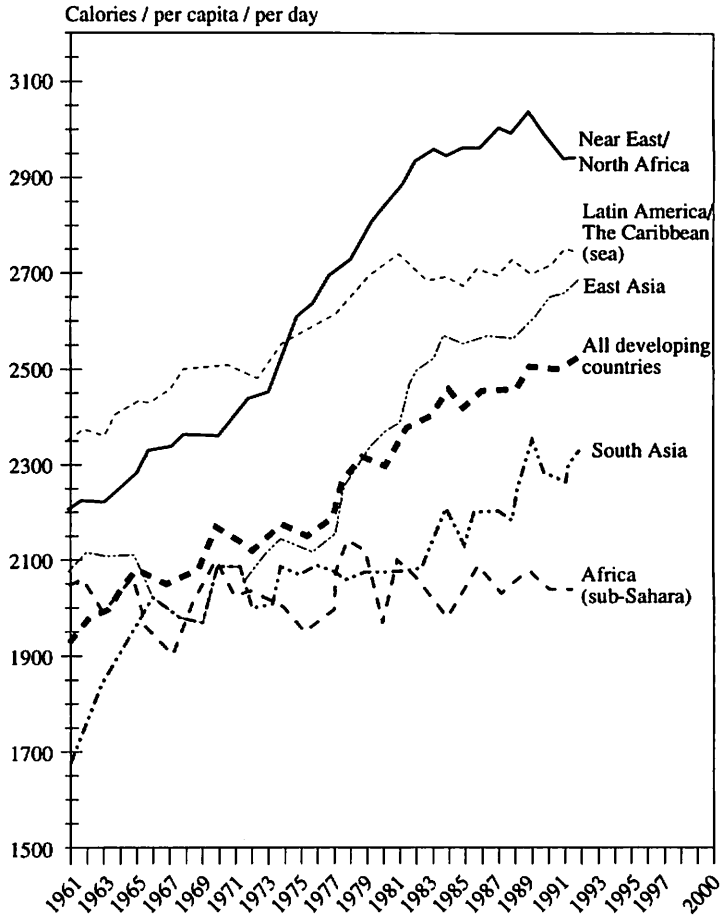
(11) See K.Fujita, "Reverse Credit Flow? Case Studies of Rural Informal Financial Markets in Bangladesh", Quarterly Journal of Agricultural Economics, Vo.49, No.4, July 1995).

(12) Hossain,M., Credit for Alleviation of Rural Poverty: The Grameen Bank in Bangladesh, IFPRI, 1990.

(13) Dasgupta,P., An Inquiry into Well-Being and Destitution, Oxford University Press, 1993.

(14) See K.Fujita, "Agricultural Issues in South Asia", IDCJ Forum, No.15, 1996).

Chart 1 Food supply per capita (calories per day) in developing countries 1961-1992.



Source : Alexandratos, N, ed., World Agriculture: Towards 2010: An FAO Study, FAO, 1995.

Table 2 Major Socio-Economic Indicators for South Asia

	India	Bangladesh	Nepal	Pakistan	Sri Lanka
Population (1994; 10,000's)	913.6	117.9	20.9	126.3	17.9
Population Growth Rate (1990 - 1994)	1.8	1.7	2.5	2.9	1.3
GNP per Capita (1994; US$)	320	220	200	430	640
GNP Growth Rate					
(1980-1992)	3.1	1.8	2.0	3.1	2.6
(1985-1994)	2.9	2.0	2.3	1.3	2.9
GDP Share classified by Industry (1994)					
Agriculture	30	30	44	25	24
Industry	28	18	21	25	25
Service	42	52	35	50	51
Agricultural Share of the Workforce (1990)	64	65	94	52	48
Rural Population ratio (1994)	73	82	87	66	78
Calorie Supply per Capita per Day (1992)	2,395	2,019	1,957	2,316	2,275
Average Life Span after birth (1994)	62	57	54	60	72
Ratio of Adult Literacy (1995)	52	38	27	38	90
Female only	38	26	14	24	87

Source : World Development Report 1996' - World Bank,
Human Development Report 1996' - UNDP

Table 3 Agricultural Performance in South Asian Countries

	India	Bangladesh	Nepal	Pakistan	Sri Lanka
Self-sufficiency Ratio in Grain (1988-90)	106	87	100	97	62
Agricultural growth Rate (1981-92)	3.0	2.3	4.2	4.4	1.8
Grain Production Share (1990)					
Wheat	33.8	5.3	18.8	74.3	—
Rice	45.6	93.9	48.4	16.6	92.2
Corn	5.8	—	27.1	6.1	2.0
Millet	6.7	0.3	5.1	1.0	0.5
Sorghum	7.1	—	—	1.3	—
Production Growth Rate					
Grain (1970-80)	2.3	2.4	0.5	4.0	3.6
(1980-90)	3.3	2.6	4.6	1.9	1.3
Wheat (1970-80)	5.2	22.8	6.8	4.7	—
(1980-90)	4.3	1.9	6.6	3.0	—
Rice (1970-80)	1.7	2.0	0.3	3.6	3.6
(1980-90)	4.1	3.0	3.6	-0.0	1.1
Corn (1970-80)	0.6	—	-1.4	2.9	4.4
(1980-90)	3.5	—	5.8	2.5	3.4
Millet (1970-80)	-1.0	—	-0.6	-2.8	—
(1980-90)	1.4	—	6.5	-3.4	—
Sorghum (1970-80)	2.8	—	—	—	—
(1980-90)	-0.3	—	—	—	—

Source : Calculated by the author on the basis of the attached statistical tables of 'World Agriculture in 2010'; FAO.

Table 4 Agrarian Structure in South Asian Countries

	Bangladesh	Pakistan	India [a]			
			East India	North India	South India	West India
Total number of households in rural areas (10,000')	1,382	1,363				
Farm households (10,000')	1,005	765[b]	2,115	1,966	2,029	1,275
Non-farm households (10,000')	377	594				
Ratio of the above (%)	27	44	(41)[c]	(27)	(56)	(34)
Average area operated by farm households (ha)	0.83	3.78	1.09	1.18	1.41	3.14
Share of farm households (%)						
Small-scale farmers (~ 2 ha)	87	47	86	84	80	54
Medium-scale farmers (2 ~ 10 ha)	12	46	14	15	18	41
Large-scale farmers (10 ha ~)	0	7	0	1	1	5
Share of farm households (%)						
Owner farmers	63	69		74		
Owner-cum-tenant farmers	36	12		22		
Tenant farmers	1	19		4		
Tenant Farmland Ratio (%)	18.5	26.5		10.6		

Notes : a. East India : Assam, Bihar, Orissa, East Bengal and the eastern hill states.
North India : Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttar Pradesh, etc.
South India : Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, etc.
West India : Gujarat, Madhya Pradesh, Maharashtra, Rajasthan, etc.
b. Including farmers who concentrate on livestock.
c. The ratio of agricultural laborers within the agricultural related workers population.

Source : Bangladesh : Agricultural census 1983-84.
Pakistan : Agricultural census 1990.
India : Agricultural census 1985-86, but agricultural laborers population ratio is taken from the Population census 1991. The structural ratio of farmers and tenant farmers classified by farmer type are taken from the National Sample Survey (round 26) and they are numeric values for the period 1970/71.

Table 5 Comparison of Different Development Policies Given Expenditure of Rs 220,000

Scheme	Increase in Vaccage Production	Increase in Incomes (in Rupees)			
		Landless Laborers	Small Farmers	Medium Farmers	Large Farmers
Boriya :					
Industrial decentralization	303,974	68,508	122,936	80,456	100,144
Irrigation	111,772	3,788	3,378	14,266	28,062
IRDP : Buffalo	242,831	63,181	16,155	13,200	21,315
IRDP : Self-employment	578,090	251,177	30,725	29,405	28,841
Aurepalle :					
Irrigation	259,588	25,645	52,402	29,297	41,426
IRDP : Buffalo	294,838	98,630	39,342	18,485	14,736
IRDP : Self-employment	570,358	238,744	62,890	32,942	34,071

Source : Parikh, A. and E. Thorbecke, "Impact of Rural Industrialization on Village Life and Economy : A Social Accounting Matrix Approach", Economic Development and Cultural Change, 45, 1996

Chapter Five

Appraisal and Future of the Green Revolution

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Introduction

The world population has increased at a higher rate than was ever experienced before the war, and food demand has increased rapidly as a result of a population explosion in the developing countries after the second world war. However, although the world food supply has had several crisis periods, up until now the expansion of supply has been sufficient to cope with the increased demand without permanent worldwide shortages.(1) The Green Revolution has made a significant contribution towards avoiding a global scale Malthusian crisis which may have occurred if the food supply had not been expanded.

As is commonly known, the Green Revolution is the realization of a worldwide increase in grain production by popularizing new breeds of high yielding varieties which have been developed by the International Rice Research Institute (IRRI) in Los Banos, Philippines, an international agricultural research institute originally established by the Rockefeller and Ford Foundations in the 1960's, and popularization of new breeds of corn and wheat developed by the [Current International Maize and Wheat Improvement Centre] (CIMMYT) which the Rockefeller Foundations has been promoting since the 1940's in Mexico. This development of 'High Yielding Varieties' is defined as a typical example of international agricultural technological transfer from developed countries, such as America and Japan to developing countries.

In this chapter, which only covers rice as it has special significance in Asia, the Green Revolution will first be considered from a technical angle, then economically and socially, and finally we will try to appraise its future prospects.

1. Technical Appraisal of the Green Revolution

Technical reformation is the core of the Green Revolution and has involved

the development of new varieties to replace the existing traditional ones, which up to now have been widely cultivated in Asia. Initially, these new varieties were known as 'High Yielding Varieties' (HYVs) due to their significantly higher grain harvest compared to the traditional varieties. Then as they evolved, they were named the modern varieties (MVs) as not only did they have a high yield, but also improved taste and greater resistance to disease and insects.

Various factors including good irrigation conditions and increased fertilization are necessary to realize the Green Revolution, but it would not exist at all without the development of these modern varieties. So, reconfirmation of the nature of these modern varieties, which deserve to be called revolutionary, may be needed. First of all, the changes in the modern varieties will be clarified after summarizing the general character of the ordinary varieties.

1. The Character of the Traditional Varieties [2]

The traditional varieties of rice which were previously wide-spread over Asia in the tropical regions were tall, but didn't grow very well and their leaves were often yellow due to malnourishment as there was insufficient nutrition (especially nitrogen) in the soil. The yield was quite low per hectare, compared to the average in the temperate zone of 5.6 tons (of hulls) in Japan, and even in Indonesia, the country with the highest yield, the average was only 1.8 tons, and there were some countries whose yield was less than one ton on average in the 1960's. However, three tons were the maximum in Asia, although the yields in the test area in the agricultural test fields was higher.

The understanding in those days was that the same yield as the temperate zone couldn't be expected because of high temperatures in the tropical zone, soil productivity was low as the soil had suffered strong weathering, and disease and insects thrive in these weather conditions. It was thought that Indica Varieties could not improve the yield even with increased use of fertilizers as it's ability to assimilate nitrogen was considered weak, and it apparently couldn't produce protein through assimilation of nitrogen rich fertilizer well. To use an analogy, the traditional varieties in the tropical zones were like rice that has

poor digestion, so if it is overfed with fertilizer, it would suffer from diarrhea.

However, after analyzing the photosynthesis of rice using an infra-red gas analysis machine which had been developed at the time by mainly Japanese biologists in IRRI, it was later clarified that the yield was poor because the rice leaves became too big, as its nutrient intake ability was actually rather better than previously thought, and the plants fell down making it difficult to bear fruit.

Another important feature of the traditional varieties in the tropics is although planting takes place in the dry season from January to February, flowers don't bloom till September/October, by which time the daylight is shorter, as its sensitivity to light is very acute. If there is enough water, rice can be produced in the dry season and a much higher yield can be expected as the solar energy is more powerful than during the rainy season, but because it takes so long to grow, eventually it has been produced in the rainy season which has sufficient water.

Also, for the traditional varieties produced in the rainy season, it used to take 160-180 days before harvesting. So for those reasons, there was usually only one crop of the traditional varieties per year.

2. Character of the Modern Varieties and its Development [3]

As a result of research by IRRI, it was established that solar energy can be better harnessed by changing the shape of the rice. In other words, if the rice form is improved so that the head (ear) is shorter and thicker, and the leaf stands more upright to receive the sunshine, and by developing a shape which strengthens an offshoot, then if it is fed more fertilizer, the yield of rice will be increased by gathering the sun's rays more effectively.

Also, if rice is planted in the dry season, high yield can be expected as the solar energy is sufficient, but irrigation facilities are needed to enable production in the dry season as much water is needed for rice. Also, if it is very light sensitive, as are the ordinary varieties, the flower doesn't bloom until September/ October when the daylight becomes shorter, so if the growing period can be

shortened to 100 days by producing varieties whose light sensitivity is reduced, harvesting is possible within the dry season and it will be possible to have two or three harvests a year in the same paddy field.

As a result of research by IRRI into the development of new varieties to match these target specifications, it was found that Dee-Geowoo-Gen, which is a dwarf variety from Taiwan, was the most promising starting material as it is responsive to fertilizers, and this led to the successful development of a revolutionary new variety called IR8 by cross-breeding it with the Peta variety from Indonesia in 1966.

IR8 is an Indica rice which was only 60% of the height of the ordinary varieties earning them the name semi-dwarf, and many more grains were produced without it falling down when it was well fertilized, as the stalk was thick and much sunlight could be harnessed as the leaves stood upright. IR8 was a really revolutionary variety which gave a high yield of eight tons per hectare under the right conditions, by reducing the negative characteristics of the traditional varieties.

The cultivated area rapidly expanded from 2 millions hectares in the rice growing season of 1967/8, to 4 million in 1968/69, after the distribution of the IR8 seeds to farmers, and there was an increase in rice production also.

However, although IR8 had the above qualities, its resistance to disease was weak, and virus diseases which were not common before suddenly increased, and damage by harmful insects such as the leafhopper and fly also increased. Also, it didn't taste as good as the traditional varieties.

The IRRI tried to modify development of the new varieties by using low input technology instead of high input technology to rectify those failings in IR8, and IR5 in 1968, and IR20 in 1969, were developed to be more resistant to disease and insects, and to be taller than IR8. However, insects quickly adapted to the challenge, and the damage caused to IR20 became greater, so in 1973, IR26 was recommended as the strongest variety against the leafhopper, fly, grass moth, and virus and white dry disease.

Additionally, significant damage was done by a previously unknown type

of brown leafhopper in Indonesia in 1976. However in 1976, the newly announced IR36 which was bred from thirteen combinations of 'parent plants' was selected, as this was resistant to many diseases and it was planted in more than 10 million hectares in south east Asia in 1982, which represented 13% of the total cultivated area.

A see-saw battle has evolved whereby if a new type of rice is developed and popularized, the disease and insects race to adapt themselves to it within a short time, and damage it again as above. Therefore, although it is called the Green Revolution, revolution was not a one-time event, but a long term battle against the disease and insects which developed more resistance and continued to attack the new varieties. (4)

The important issue for this development process when the Green Revolution became popular in all Asian countries was to develop and popularize modern varieties suited to the different environments within each country, which made up for the weaknesses of the IR varieties by having added resistance to disease and insects and the preferred taste of the consumers, which the ordinary varieties had, through cross-breeding research with the local ordinary varieties in each countries agricultural test sites. The localization of these IR varieties has been accepted by many farmers as increasing the resistance to blight/harmful insects, improving the taste, preventing the sales price falling as well as stabilizing yields of the new varieties.

Although in the introduction, the Green Revolution was defined as a typical international agricultural technological transfer, it is not only the transfer of technology to the developing countries from the developed countries, but also there is an essential sense in developing new varieties which are suitable for each local environment in the relevant developing countries by using modern technological knowledge derived from the developed countries.

3. Summary of Technological Characteristics of the Green Revolution

The technological characteristics of the Green Revolution based on the development/popularization of the modern varieties as above, will be concluded

after the research results of rice crop farmers in eight countries are summarized by IRRI, classified by traditional and improved varieties, irrigated and rain-fed fields, and rainy and dry seasons for countries which supplied data, as shown in Table 1.[5]

(1) Three factors of improved varieties, increased fertilization and irrigation: Technological essential of the Green Revolution is Biological-Chemical Technology (BC Technology), and it is certain that if the three basic factors which yield the best volume per hectare are accomplished, such as high yielding improved varieties as the bio-technology element, chemical fertilizer which results from the chemical industry developments, and irrigation facilities are in place to raise the effectiveness of both BC technologies, it will become complete.

(2) Increased fertilization and increased yield of improved varieties: High yields in the Philippines result from an average of more than 150 kilograms of fertilizer per hectare, but at the other end of the spectrum, Cambodia is much lower at 40 kilos per hectare using the same improved varieties and irrigation conditions.

(3) Low fertilization and low yields of the traditional varieties: The average amount of fertilizer used is quite low for the traditional varieties, and the yield from rain fed fields is also low for all countries.

(4) Price ratio between fertilizers and rice, and investing in fertilizers: If the price ratio is more than 200% greater, the investment in fertilizers is low (in Philippines, Thailand, Nepal etc.).

(5) Effect of irrigation on improved varieties: The yield from irrigated fields is clearly higher that rain fed fields (in Philippines, Indonesia etc.).

(6) Effect of irrigation on traditional varieties: The difference of the yield is not clear (Cambodia).

(7) High yield from improved varieties/Irrigated fields in the dry season: The yield is high if there is sufficient water supply and sunshine as the volume of the improved varieties from the irrigated fields in the dry season is high compared to the rainy season (Philippines and Bangladesh).

(8) Labor intensity, area scale and yield: In China, the scale is small, and it is labor intensive and the average yield per hectare is higher than other countries, whereas the opposite is true in Thailand, which has large scale cultivation, the work-force is small and the yield is low per hectare.

(9) Year-round production of the improved varieties in irrigated fields: Normally two harvests per year, but in Indonesia they achieve an average of two and a half harvests per year. In comparison, the traditional varieties are only once a year. Therefore, the yield per harvest is larger, and also the total yield per year for the improved varieties in the irrigated fields is correspondingly higher.

(10) Machine use and year-round production: As mentioned before, the substance of the Green Revolution is based on BC technology, and the percentage of tractor use is high as machine use makes year round production easier.

4. Increased Production Results from the Green Revolution.

Rice production throughout the world has rapidly expanded in the last thirty years, centered on the Asian region, as a result of the Green Revolution development which is accompanied by the above increase in yield effect. (Table 2.)

The total rice production volume in the world has doubled within the last thirty years from 250 million tons in the early 1960's, to 530 million tons in the 1990's, mainly due to the doubling of Asian rice production which represents more than 90% of the world's total production volume. During that period, the cultivated area throughout the world has been expanded by about 15%, but the main reason for the doubling of rice production is the increase in yields of about 80% per hectare. In other words, it can be said that rice production in the world has doubled through the high yields of the modern varieties.

These high yields are the result of developments in the BC technology of the Green Revolution. A Malthusian crisis has not occurred due to the development of agricultural technology which he ignored. By contrast,

Boserup's assertion is that economic development by raising agricultural productivity through agricultural advancement follows the historical trend from the original slash-and-burn cultivation to the cyclical cultivation, then to the intensive cultivation under the increased population pressure, and this theory may be approved as pertinent in preference to Malthus.

2. Economic and Social Appraisal of the Green Revolution

1. Macro Contribution of the Green Revolution

As seen above, the technical result throughout the world of the Green Revolution was increased yields of rice, which raised the ratio of self supplied food in populous countries in Asia, including India and Indonesia which had relied heavily on imported food, and made a great contribution to improving the balance between the food supply and demand world-wide, not just in those countries, and also played an important role in solving the global food problem.

It is worth noting the rapid economic growth in Asian countries recently, but the existence of this agricultural development and increased food yield should not be ignored as a factor. Although low labor cost is one of conditions for strengthening international competitiveness when industrializing the developing countries, the significant increase in food yield resulting from the Green Revolution made a contribution to industrialization through controlling the rise in food prices, which has a strong effect on wages. It is remarkable that Japan and the NIEs are expanding businesses in the developing countries at present, but the significance of increased yields in food which has contributed to maintaining low labor cost is large. It is no exaggeration to say that the Green Revolution has made a positive contribution to the dynamic development of the macro economy in Asian countries. This fact is clear if we compare the sluggish economies of African countries which still suffer from food shortages and are receiving grant aid food every year.

The Green Revolution contributed to the supply of low-cost food, the

expansion of the fertilizer industry, acted as a stimulus to related industries through the increase of food distribution for city residents who are net food consumers or people who are engaged with non-agricultural work in rural areas, and may also have eased social tensions by giving easy access to food for the most impoverished peoples who work in the urban informal sectors.

Thus, it can be considered that the Green Revolution has contributed positively to the world food problem and general economy and society of each country.

2. Influence of the Green Revolution on the Rural Society

However, appraisal of the effects of the Green Revolution on the society in rural areas, especially regarding the influence on the income structure and distribution, has been mixed, with some positive and some negative assessments, due to the differences between regional rural conditions and the economic scale of farming.

The first cause of these different appraisals is the technical character of the Green Revolution. In other words, the basic technical premise for the introduction of the Green Revolution is whether or not it has an adequate water supply, or as a bare minimum, that it can expect a certain amount of rain-fall in the rainy season. There is no way to introduce the Green Revolution in the arid regions with almost no rain, or the semi-arid regions. Therefore, it can be said that those areas may never have had a chance to benefit from the Green Revolution, even though they are within the same country or within Asia.

It is said that even in areas which have a good water supply, back in the 1960's when the Green Revolution just started, for economic reasons and lack of technical knowledge, poverty stricken small-scale farmers couldn't get any fertilizers or modern seed varieties easily. On the other hand, large-scale farmers with financial clout and know-how positively accepted the Green Revolution, resulting in some farmers within the same village benefiting while others did not, so some asserted that the Green Revolution caused social inequality in rural areas by increasing the difference in economic strengths of some farmers.

In addition, there are more than a few who are anxious about the expansion of the gap between the large-scale wealthy farmers and the poor farmers or landless workers because of the changes to the social customs in rural areas brought by the introduction of modern varieties, where they had previously employed many landless workers at harvest time for the traditional varieties [7], and for instance, by changing the harvesting tools from 'aniani' to sickles in Indonesia after the advent of the Green Revolution. [8]

Then, it used to be said that it was difficult for small scale farmers, who have long been growing the traditional varieties which did not require fertilizers, to adopt modern agricultural methods which require water supply and fertilizers for production of modern rice varieties. However, as Shultz said, even though small scale farmers are not particularly knowledgeable, once they find that one agricultural product brings a certain profit, they have the ability to grab these economic opportunities. If they see their neighbor's farmers getting a guaranteed profit through introduction of the Green Revolution, they will surely try to adopt the new technology. [9]

Farmers respond sensibly to changes in the price ratio between fertilizers and rice in both of the developed and developing countries, and take rational economic action. Table 3 shows the recurring result between the relative price of fertilizer against rice and fertilization costs per hectare, although the determination coefficient is not so high, fertilizer's t-value parameters of relative price to rice is meaningful, and it proved this rationale. [10]

There is an assertion denying the opinion that it causes increase inequality of income distribution in rural areas. Kikuchi established by the analysis of the rural areas in Laguna, Philippines, that the Green Revolution raises the income for laborers relative to the cost of the land, and it reduces economic inequality. [11] Hayami also confirmed that small scale farmers introduced the modern varieties at an earlier stage through research in 30 rural areas in Asia [12], while Cristina David and Otsuka reached a similar conclusion from their research within seven Asian countries in 1985-1988 as well. [13] It may be natural to think that small scale farmers introduced the modern varieties earlier, except in the initial period

when there was a cost restriction, as the Green Revolution can increase the yield by of concentrated working. Additionally, it can be considered that the laborer's income was increased by greater annual working opportunities through year round harvesting. It can be said that the Green Revolution contributed to bringing a standardization to earnings potential through expansion of labor demand which gave a working opportunity to landless workers in the rural areas, and itinerant workers from depressed areas and also equalization of income. [14] Furthermore, although the Green Revolution was difficult to introduce to areas with poor irrigation, it indicated some useful points to ease the low income problems of the impoverished class by easing the income differences between areas and reducing the sales price of rice by improving distribution to the non-agricultural workers, or to farmers producing crops other than rice in those areas.

Although the Green Revolution has a different effect on different classes of farmers depending on the conditions of the rural area, the cultivated area of each farmer and the family structure, when we look at the whole picture, it is thought that the possibility of the Green Revolution increasing the social unfairness further in the rural areas is small from the mid and long-term view points.

3. Future Prospects and Issues for the Green Revolution

As previously described, it can be said that the Green Revolution was an agricultural technological reformation which prevented a serious food shortage or Malthusian crisis, without which these may have occurred, and the world-wide revolution resulting from this international cooperation, through the international technological transfer from the developed countries, and the positive reactions of governments and farmers in the developing countries, will surely be recorded as a major historical event.

In the earlier developing stage, it may destroy the customary farming village social order which has been maintained for eons. However, it can be

said that it was necessary if it is considered as one process in the modernization of society.

However, the Green Revolution has some problems with environmental preservation, which has recently attracted more concern, and sustainable agricultural development. The previous environment and ecosystem may be changed by excessive use of chemical fertilizers and agricultural chemicals and the over-use of water by pumping to increase the yield. Also, if only specific varieties of rice are planted over a large area, each areas own traditional varieties which have been a part of the local natural environment may face extinction. Poor harvests may occur if only specific varieties are planted over a large area and are damaged by disease and insects or frost as well. (15)

It is necessary to think about the cultivation of different modern varieties to prevent those poor harvests in the short term, and conscious daily efforts must be made to preserve the many kinds of traditional seeds to guarantee future improvements to the crop varieties. Also, it may be necessary to improve the varieties to create ones kinder to the natural environment, and more suited to the natural ecosystem through low input.

There is a clear trend that as consumer's income increases, they eat less rice but choose tastier varieties, whereas in the past they ate more tasteless rice, as seen by the change in rice demand in Japan. In other words, even though the yield may be reduced, modern varieties also need to be improved to taste better, to maintain the demand for rice from high income consumers. (16)

Of course, there are still many people in other areas who prefer quantity to quality. Thus efforts should continuously be made to improve the high yield varieties for those people as before.

It is interesting that the political implication, as presented in the report of David and Otsuka, expresses doubt about the technological development efforts for rice for inefficient/poor environmental areas because negative points in that area can be eased by market adjustment over factors and products even though the poor environmental areas don't receive any benefit from the Green Revolution. However, it is asserted that areas which anticipate the benefits of

the Green Revolution should decide whether an investment in water supply or rice varieties is more cost effective. Although both investments may be expensive, the possibility of international cooperation should always be looked into between developed and developing countries to prevent a global Malthusian crisis while learning from the Green Revolution.

Notes

1. It is not denied that starvation within populations, which is strongly related to the poverty problem, still exists in the world.
2. Akira Tanaka, "Green Revolution and I", *Twenty years of the Green Revolution,* Regional Research Institute of Agriculture in Pacific Basin, Nihon University 1987, page 24-28.
4. Yujiro Hayami shows that this is a continuously improving process which applies science to the biological production process rather than the Green Revolution being completed by development of 'miracle rice', and he mentions that this is the real substance of scientific agriculture. Hayami, *Development of Economics,* Sobunsha, 1995, page 91.
5. Saburo Yamada, *Comparative Study of Development of Asian Agriculture.* University of Tokyo Press, 1992, page 267-270.
6. Ester Boserup, *Conditions for Agricultural Growth, Economics of change in an agricultural economy due to population pressures,* jointly translated by Shuichi Yasuzawa and Mine Yasuzawa, Minerva Books, 1975, (written in 1965).
7. There is a social custom that people involved with the harvesting can keep some of harvest, known as 'bawon', and Natsuki Kanazawa said that it can be called a distribution society due to the coexistent purpose of increased opportunities to give income to many people instead of labor is necessary for the harvesting work. Kanazawa, 'Seeking for the style of South East Asian Rice Agriculture' *Twenty years for the Green Revolution,* page 15-16.

8. Norio Egaitsu expressed the view that the Green Revolution had a poisonous side effect which was destroying the conventional order of society. Egaitsu, *Starvation and Satiation,* Kodansha, 1994, page 76-77.
9. T. W. Schultz, *Transforming Tradition Agriculture,* New Haven, Yale University Press, 1964.
10. Saburo Yamada, Refer to the source in the table 3.
11. Masao Kikuchi, 'Introduction of new technology and farmers' *Twenty years for the Green Revolution,* page 79-80, 83.
12. Hayami, 1995, page 196.
13. Cristina C. David & K. Otsuka, eds., *Modern Rice Technology and Income Distribution in Asia,* Lynne Rienner Publishers and IRRI, 1994.
14. Same as the above, Chapter 12
15. It can be thought that Japanese significant poor rice crop in 1993 was caused by too great an inclination to the certain variety i.e. Koshihikari in all areas.
16. 'Tongil (Unification)', a high yield variety in Korea, had been popular in half of the total planted area by 1980, and it contributed much to self sufficiency of rice production in Korea. However, as national income was raising, people gradually stopped eating 'Tongil' rice because of its poor taste, and the stock increased, and the financial responsibility became the government's problem then, so it is hardly produced at all now. Ekaitsu, 1994, page 80.

Table 1 Data related to the Green Revolution in Asian Rice, 1987-1990

Water Supply	Varieties	Country	Philippines		Bangladesh		Thailand		Cambodia		China	Indonesia	Vietnam	Nepal
		Average Yield per Country (t/ha)	2.7		2.4		2.7		1.2		5.4	4.0	2.9	2.1
		Period	Rainy	Dry Season	Rainy	Dry Season	Rainy	Dry Season	Rainy	Dry Season				
High Yield Improved Varieties	Irrigated Fields	1 Ratio of Improved varieties (%)	100	100	100	100	61	86	100		96	100	100	100
		2 Harvest Yield (t/ha)	4.1	6.1	3.5	5.1	4.2	3.8	2.7		6.3	5.5	4.6	2.9
		3 Fertilizer (kg/ha)	109	149	126	150	77	121	46		63	197	173	42
		4 Ratio of Price of Fertilizer to Rice (%)	188	217	184	194	320	273	200		122	150	300	293
		5 Working Time (Hrs/ha)	70	74	159	203	58	42	123		334	126	89	128
		6 Ratio of Tractors (%)	97	97			100	100				43	68	69
		7 Ratio of directly planted (%)	53	57			89	87					100	
		8 Ratio of Multi-period Production (%)	200	200			181				74	253	200	100
		9 Cultivated Field size (ha)	2.14	2.01	-	-	2.81	3.23	0.58		0.22	0.57	1.30	2.03
	Rain-fed Fields	1 Ratio of Improved varieties (%)	100									100		80
		2 Harvest Yield (t/ha)	3.5									3.8		2.2
		3 Fertilizer (kg/ha)	86									217		13
		4 Ratio of Price of Fertilizer to Rice (%)	267									155		314
		5 Working Time (Hrs/ha)	69									135		114
		6 Ratio of Tractors (%)	77									7		13
		7 Ratio of directly planted (%)												
		8 Ratio of Multi-period Production (%)	100									141	2.07	97
		9 Cultivated Field size (ha)	0.76									0.37		
Ordinary Varieties	Irrigated Fields	1 Ratio of Improved varieties (%)							23		39			
		2 Harvest Yield (t/ha)							1.9		5.1			
		3 Fertilizer (kg/ha)							53		93			
		4 Ratio of Price of Fertilizer to Rice (%)							200		122			
		5 Working Time (Hrs/ha)							94		268			
		6 Ratio of Tractors (%)							25		6			
		7 Ratio of directly planted (%)							5					
		8 Ratio of Multi-period Production (%)									139			
		9 Cultivated Field size (ha)							0.60		0.21			
	Rain-fed Fields		Dry Field				Deep Water					Dry Field	Deep Water	
		1 Ratio of Improved varieties (%)												5
		2 Harvest Yield (t/ha)	0.9		2.6	1.7	1.3	2.3	2.1			1.8	2.6	1.9
		3 Fertilizer (kg/ha)	16		45	27	4		30			54	15	16
		4 Ratio of Price of Fertilizer to Rice (%)	314		184	206	407	0	200			138	154	244
		5 Working Time (Hrs/ha)	73		132	152	40	37	175			70	39	149
		6 Ratio of Tractors (%)					98	100					64	
		7 Ratio of directly planted (%)	100				100	80				100	100	
		8 Ratio of Multi-period Production (%)	100				100	100				100	100	68
		9 Cultivated Field size (ha)	1.10		-	-	6.50	8.40	0.23			1.51	2.10	1.30

Note : The years investigated were 1987-90, although they differed from country to country,
Source : Yamada 1992, page 268 based on the IRRI, World Rice Statistics, 1990. pages 266-296.

Table 2 Changes in rice production, harvest area, and yield per hectare, 1961-65 and 1992-94

	1961 - 1965	1992 - 1994	Ratio
Production (Million tons)			
World	253.2	529.5	2.09
Asia	233.6	482.2	2.06
(Compared to the World)	(92.3%)	(91.1%)	
Harvest Area (Million hectares)			
World	124.1	147.0	1.18
Asia	114.5	130.6	1.14
(Compared to the World)	(92.3%)	(88.8%)	
Yield per Hectare (kg/ha)			
World	2,040	3,602	1.77
Asia	2,040	3,692	1.81
(Compared to the World)	(100.0%)	(102.5%)	

Source: FAO Production Yearbook, 1976, 1994

Table 3 Regression results of fertilizer's relative price to rice on fertilizing rice per hectare:1961-1986

Dependent Variables: Fertilizers per hectare	Relative price of fertilizer to rice Coefficient	(t-value)	Determination Coefficient (R^2)
I. Developed countries			
Japan	-0.139	(-3.356)***	0.349
II. NIES			
Taiwan	-0.200	(-3.063)***	0.281
III. ASEAN			
Thailand	-1.207	(-4.335)***	0.511
Indonesia	-1.076	(-5.484)***	0.639
National Pool	-1.083	(-8.139)***	0.332

Note: *** indicates significance at 1% level.

Source: Saburo Yamada 'Comparative Analysis of Changes in the Rice Price in Asian Countries: 1950~1986', *Institute of Oriental Culture, University of Tokyo, - The Fiftieth Anniversary of Foundation Commemoration Papers,* 1992

Chapter Six

Food Supply and Demand in the Year 2020 and the Necessary Reform in Japan's Agricultural, Forestry and Fishery System

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1. The Long-Run Causes of the Grain Crisis in 1996

The world grain stock ratio (ratio of stock volume against use volume) has shown a tendency to fall since 1987, whilst the grain price has risen. According to the data released in August 1996 by the United States Department of Agriculture (USDA), the total grain stock ratio was 13.7% at the end of the crop year of 1995/96, the details of which are shown in Chart 1, such that wheat was 18.9%, rice was 13.0%, and coarse grain (grains other than rice and wheat, such as corn and barley which are mainly used for feed) was 10.5%; they are just around, or much lower than, the 17% mark which is the safety standard of the Food and Agriculture Organization (FAO) of the United Nations. These stock ratios are at the worst level since the war, except for rice, and are lower than the level during the food crisis year of 1974. Estimates for the end of the harvesting season in 1996/97 are nearly the same as the previous season and they are in 13.8%, 19.3%, 12.5% and 10.6% respectively. Mr. J. A. Sharples, a specialist on the world grain market from the United States Department of Agriculture, mentioned in the fourth issue of *Choices* magazine in 1995 that the falling world total grain stock will reach a very low level in autumn 1996, and 72% of the stock is the pipeline stock in the marketing channel and 27% is the national reserve stock to cover poor harvests in each country such as China and the ex-Soviet Union, etc. Especially he said that the stockpile of major grain exporting countries such as America and Canada, which have played the role of international grain reserve stock holding countries since the war, will be only 1.4% of the estimated low world grains' stock. The world grain market was really near to crisis. The Chicago grain futures price and rice export price in Bangkok have been increasing since the beginning of 1995, with the price of corn reaching $5.48 per bushel on July 12th, 1996, the highest price on record, wheat is around $5 which is a 15 year high, and the price of soya beans also increased approximately 30% since last October in reaction to this situation.

The Bangkok free-on-board (FOB) export price of 100% first grade rice rose to $465 per ton on September 5th, 1996, which was also a 15 year high.

Although some of this reduction in grains stock ratios and the subsequent increase in grain prices are caused by short term reasons, such as reduced production of rice and coarse grains in the 1995 crop year in America, surplus investment funds flowing into the grain futures market caused by a general slow-down in business of high income countries and the increased price of feed grains caused by an increase in the price of American beef due to mad cow disease; basically they are influenced by long term factors such as transformation in agricultural policy during the late eighties through to the nineties in both Europe and America, probable the limits in agricultural technology improvement, restrictions in and degradation of natural resources such as soil and water, a slowdown in the rate of increase of the world grain yield from the seventies to the eighties as a result of the limits of photosynthetic ability of weal plants, the world population explosion and the rapid increase in demand for feed grains caused by the high economic growth in Asia, most notably in China. These long term causes and their influences on food supply and demand in the 21st century are considered in this chapter, along with the supply and demand for grains, and the agricultural policies of China and Japan.

2. Transformation of Agricultural Policies in Europe and America after the Last Half of the Eighties.

Since the last half of the eighties, the food policy in Europe and America has changed from a protectionist, surplus production and export dumping policy to a policy of reduced protection, curtailment of surpluses, correction of inter-regional differences and environmental protection. The EC eariler had achieved increased production, improving its agricultural structure and increasing the income level through variable import levies of the Common Agricultural Policy

(CAP), export subsidies and domestic price support. It also became self-sufficient in major agricultural products within the region by the first half of the eighties. Until the seventies, it used to be a net importer of grains, at an average of approximately 30 million tons annually, but by 1984 it had become a net exporter, and by the subsidies of CAP, it exported more than 20 million tons annually by the end of the eighties. The excess agricultural products stock in the EC reached an enormous level, such as 1.7 million tons of butter by 1986, 620,000 tons of skimmed powdered milk and 610,000 tons of beef in 1984. The financial burden for the price support and the export assistance contributing to the excess agricultural products reached its limit. The European Agricultural Guidance and Guarantee Fund (EAGGF) the amount of which represents the level of the price support and export assistance for the excess agricultural products of CAP become nominally 1.8 times higher in 1985 compared to 1979-81, and 1.2 times in real terms.[1] The transformation in the EC agricultural policy started with production control and decreasing the support price in 1982, and they were gradually strengthened, then were expanded to environmental maintenance and reduction of inter-regional differences, whilst ensuring the objectives of improved productivity, stability of supply and farmers livelihoods, and sound pricing of CAP as stated in *The prospects of the Common Agricultural Policy* (Green Paper) in 1985. A comprehensive financial reform plan (Delor package) in 1987 was also heading in this direction, and was agreed by the European Board of Directors in February 1988. The 'stabilizer' which reduced the financial burden, and 'set aside' which was intended for production reduction and environmental preservation were introduced along with the mid term financial plan which started in the same year. Finally, a significant agricultural reform in 1992 were agreed including big reductions in the support prices, production control, protection for the medium and small scale farm managements (special assistance for the agricultural management by the youth), the preservation of the environment by the extensification policy (special action for the disadvantaged areas and environmental preservation areas). Then these reforms were subsequently merged with the agreements of the Uruguay Round

Talks of 1993, whose major characteristic were tariffication of the variable import levies, minimum access import, reduction of export subsidies and decrease of domestic protection.

Grain export from America continued to increase, reflecting the strengthened U.S. agricultural protection and taking advantage of the world food crisis in 1974, from 40 million tons in the sixties to a peak of 112.7 million tons in 1981. The Federal government agricultural financial expenditure in America rapidly increased nominally by 2.2 times and by 1.7 times in real terms by 1985 from the period of 1979-81.[2] However, grain exports fell sharply during the first half of eighties, reflecting excessive domestic protectionism, a strong dollar and the rapid increase of grain exports from the EC, and the total U.S. grain stock increased significantly from 50 million tons in the mid-seventies to 200 million tons by 1986. Stocks of individual agricultural products did increase. The stock of butter increased from 50,000 tons in 1975 to 230,000 tons in 1984, skimmed powdered milk from 200,000 to 640,000 tons, wheat from 11.8 million to 38.1 million tons, coarse grain from 15.5 million to 31.7 million tons[3] and milled rice to 2.5 million tons in 1986, equivalent to half the total domestic production volume. Financial expenditure increased rapidly to an excessive level to protect domestic agriculture and to support export of the excessive stock of agricultural products. To cope with these problems the following policy measures were introduced by the 1985 Agricultural Law. They were flexibility or reductions in grains planted area for the first time by the 50/92 policy, reductions in the target price and the farm support price (loan rate), the Conservation Reserve Program (CRP) which took a total of 18 million hectares of high erosion risk areas out of production through the grant of annual average rent of $121/hectare to the owners and new subsidy of marketing loan which decreased the grain export price to the international price level. These measures except marketing loan were production restriction policies, and these policies were further strengthened by the 1990 Agriculture Law, in such examples as the expansion of flexible planting and fixing the program yield which is the base for the calculation of deficiency payment subsidies to farmers.

These measures to reduce agricultural protection, surplus and financial expenditures were finally absorbed into the agreements reached in the Uruguay Round agricultural products trade agreement in 1993.

Thus agricultural policies of Europe and America had been transformed greatly from high protection, surplus accumulation, and heavy export subsidy to lower protection, less surplus, less export subsidy and more concerns to environment and less advantaged areas from 1985 to 1993. These transformations can clearly be seen in the long term reversal in the trend of net export food volume between the developed countries (with Europe and America represented the largest portion of food export of these countries) in the world and the developing countries from the last half of the eighties as shown in Chart 2. The net export volume of foodstuffs excluding fish (hereafter just called food)[4] is calculated by taking the difference between the export and import values of food for both types of countries deflated by the FAO agricultural export/import price indices respectively with 1966 base year. Before 1985 developed countries, who had been net importers of food during the sixties and early seventies, became net exporters from 1977, mainly through increased agricultural protection, surplus production and export dumping, and by taking advantage of the food crisis in the mid-seventies, and then they increased their net export volume rapidly by the early eighties. On the other hand, the developing countries changed from being net exporting regions of food to net importers as shown in the chart, and their net import volume increased rapidly. This change is caused by the fall in the food prices in the developing countries resulting from dumping exports of surplus agricultural products by Europe and America and by the policy of agricultural exploitation in the developing countries them selves. The change in the world food trade pattern from the seventies to 1985, was unfair because the developed rich industrialized countries dumped their surplus food to suppress food production and agricultural income of the poor agricultural developing countries' farmers, and the farmers in the developing countries were exploited by their governments. This change is undesirable from the view point of the comparative advantage theory because the

industrialized developed countries export or dump food to the the agricultural developing countries.

The transformation in European and American agricultural policies started in the late eighties as shown in Chart 2, was not done in order to correct this unfairness and ensure the North and South comparative advantage, but to reduce the excess financial burden of the above mentioned agricultural protection, preserve the environment and to correct inter regional differences in EC and America. Net food exports from developed countries decreased considerably in 1985, and showed a rapid reduction in the nineties. The developed countries'agricultural production index of FAO has fallen from 1986 to 1992. According to the FAO, food production per person in Europe showed a declining trend from the peak in 1984 to 1992. Also, the same tendency can be noticed in America from its peak in 1981. These changes have been enhanced by the agricultural reforms within the EC, American Agricultural Laws in 1985 and 1990, and the agricultural trade agreements of the Uruguay Round talks. Thus the transformation has caused the continued reduction in the world grains stock as previously described, and a corresponding continuous grain price increase. This transformation will be maintained into the 21st century under the World Trade Organization (WTO) system, the decoupling in the Agricultural Law of 1996 in America which will not force the Federal government to hold large agricultural surplus, and the continuous reduction of agricultural protection within the EU. The state of low global grain stocks and high grain prices will be maintained. As a result the above unfairness will be reduced, and the comparative advantage will be restored to some extent. However, the grain price will rise and will be de-stablized as the international grain stocks of Europe and America will run low, and a significant risk will result as 1.1 billion impoverished people and 800 million starving people throughout the world will face a crisis.

3. Supply Factors

Long term supply factors which regulate grain production are natural resources such as land, water and irrigation, and agricultural technology. The global cultivated area for grains has been falling annually by 0.33% in the sixties, by 0.28% in the seventies, and by 0.18% in the eighties according to the FAO data. As shown in Chart 3, the global per capita grain harvested area has fallen from 0.24 hectares in 1950 to 0.12 hectares in 1994 as a result of the population explosion and the economic limit in the expansion of the cultivated area during this period. The total grain harvest area in the world increased to a peak of 760 million hectares in 1977 as shown in the same chart, but it had since fallen to 690 million hectares in 1994. According to the data from the USDA, the grain harvest area in China has been falling since reaching a post-war peak of 98 million hectares in 1976, and had reduced by 7% to 91 million hectares by 1992. Although the grain harvest area in India increased by 14 million hectares from 1961 to its peak of 106.6 million in 1983, it had fallen by 6.26 million hectares by 1992, and this trend will continue in the future.

According to the FAO data for 1989, the total cultivated area in the world is approximately 1,500 million hectares, about 800 million hectares of which are in developing countries. Also, the total area of pasture and forest in the world is 7,400 million hectares, 42% of which is in developing countries. How much of this pasture and forest area in the developing countries can be turned into arable land for grain production is the most critical issue in order to cope with the food problem there, and the convertibility of pasture and forest to arable land in the developed countries is not relevant regarding this problem. More supply of agricultural land in developing countries is needed in order to cope with the rapid economic growth and population explosion that has been concentrated there and will be so as we head towards the 21st century. An FAO report estimated the potentailly cultivable area for at least one of the 21 important crops in 92 developing countries, excluding China, based on the data for soil

condition, topography, temperature and water supply.[5] It was more than 1,800 million hectares, more than twice as much as the current cultivated area of 760 million hectares in the developing countries. Though most of the potentially cultivable area is in South America (48%) and Sub-Saharan Africa (44%). Other institutions and researchers came up with similar estimations during the seventies. If all of the potentially cultivable area which is mostly pasture and forested land could be converted to cultivated areas, it could cover the necessary increase in the grain demand for the developing countries from the current 1.1 billion tons to 2.3 billion tons in year 2020 (my estimates that will be presented later in this paper) needed for the population increase to 6.6 billion in 2020 from the current 4.3 billion. However, such a large scale conversion of pasture and forest is unlikely to happen. In the same report, the FAO also estimated that the cultivated area will be increased by only 93 million hectares in developing countries excluding China by 2010.[6] Reasons for the actual expansion in cultivated area being very small are as follows:

(1) Generally speaking arable land expansion and growth in food production in some developing countries must be accompanied by similar increase in the demand for food by the people in those countries. Those people are mostly farmers, and when they increase food production, then they can increase their farm income, and consequently can increase their demand for food. If they did not do so, and food production were increased in other developing or developed countries, severe poverty and highly biased income distribution resulted in the developing countries in question. The developing countries in South America and Sub-Saharan Africa have a little more than 10% each of the total population of all the developing countries. Thus vast cultivable land in these areas will not be reclaimed by large amount. Asian developing countries has seen rapid economic growth and population explosion as it has taken place in China and has 72% of the total population of all the developing countries. The Asian developing countries are the countries where a large expansion of cultivated area is strongly needed. But there is not much cultivable area left in Asia.

(2) Due to economic growth, pastures and forests (and even cultivated areas themselves) have been and will be converted to houses, roads and factory sites rather than being converted to farming land.
(3) Demand for grass, livestock products which rely on pasture, and forestry products will increase along with economic growth in developing countries.
(4) Opposition to losing such non-economic value as beautiful scinery of forest and pasture, soil conservations, water conservation and flood control, and conservation of genetic resources provided from pasture and forest.
(5) Excessive public investment cost for reclaiming the potentially cultivable area in South America and Sub-Saharian Africa.[7)]

There has been rapid economic growth and also a swift conversion of farm land to non-agricultural uses in Asia. In Japan the Agricultural Land Law has been an inportant institution to preserve farm land. In Asia i.e. the world growth center, superior quality farm land has been rapidly converted to factories, houses, roads and non-cultivated land, especially in China, Thailand the Philippines, Java, etc. According to my own observations during the last twenty years, a large part of one million hectares of superior rice producing land in the Menam Chao Phraya Delta surrounding Bangkok, Thailand has been converted to non-agricultural land or unused land. The global shortage in cultivated area will increase as population explosion and economic growth will continue until early 21st century.

Soil quality has been deteriorating throughout the world. According to one research, 15% (2 billion hectares) of the total land of 13 billion hectares on the globe has been degraded.[8)] Of that total, it is said that 16% (300 million hectares) is severely degraded. In the intensive research interviews which I understock in 1993 and 1994 with about thirty farmers in all over the semi-arid North-Eastern Thailand, every farmer without exception said that they had experienced a decrease in the yield of rice and cassava within the last twenty years, and blamed the decrease in soil fertility as the cause.

Although the growth rate of global irrigated area has been above 2% annually in the sixties and seventies, it fell to just above 1% in the eighties.[9)]

The irrigated area per person reversed from the previous increasing trend since 1978, and decreased 6% by 1991. According to the FAO, this tendency in the irrigated area is a serious problem, for more than a half of the increase in the global food production resulted from the increase in irrigated area from the mid-sixties to the mid-eighties. This slowdown in the growth of the global irrigated area is governed by economic, managerial and environmental reasons.[10] Economic factors are firstly, the reduction in the real international grain price after the second world war, and secondly, the increase in the cost for building large scale surface irrigation systems within the past decades.[11] The cost efficiency of small scale irrigation systems such as Danbos in Sahel and tube-wells in India are important to note. Managerial factors are such that more than half the irrigation facilities in the developing countries currently need to be repaired and also these facilities are operated far below their designed capacity, so much water is wasted, and waterlogging and soil salinization are not appropriately managed. The environmental factors are soil salinization, which is said to occur in 10% of global irrigated areas, human diseases related to irrigation water, environmental damage caused by dams, and the external values derived from aquatic ecological environment.

As agriculture uses two thirds of the world's fresh water supply, there are strong restrictions on agricultural water resource. This water resource is being diverted to industrial and household uses as the economy grows in all the countries of the world. Exhausting underground water resource by over-utilization for agricultural purposes has been occurring in America, Northern China and India.[12] Irrigation investment has stagnated as previously mentioned. During my survey in America in the late eighties, I have personally witnessed the water shortage in California due to the difficulties in building irrigation dams because of the environment protection movements, and destructive reduction of underground water levels due to excessive pumping-out for rice crops in Texas.

The needed future increase in the world grain supply must rely on yield increase under the restrictions on cultivated land, irrigated areas and water.

The green revolution increased considerably the yield and production volume of wheat and rice from 1966 to 1982 as shown in Table 1. Each of these individual grain's yield has been increasing annually by 2.7% for wheat and 2.2% for rice, over the last thirty years. However, limitations can be seen recently on the increase of yield. The world average increase ratios of yield and grain production volume in the eighties fell sharply compared with the late seventies and also with the 1966-74 period as shown in Table 1. Although, the (theoretical) potential yield of new varieties of rice and wheat is clearly greater compared to the ordinary varieties, it is sometimes lower in experimental fields and farmers' fields.[13] Yield of new high-yield rice varieties at trial research at the International Rice Research Institute (IRRI), and national rice research centers and at farmers' fields in Asian countries, have recently been static or reducing.[14] There is a problem of excessive use of paddy fields as symbolized by triple rice harvests per year in Asia. The stagnation in yield is seen in the double cropping of rice and wheat, and also a fall in factor productivity of wheat is seen.[15]

Let's see the movement of crops' yield and production in China which is a very significant agricultural country on the globe. According to the FAO data, grain yield has increased substantially after the war from 1.9 tons per hectare in 1961 to 4.5 tons in 1994. Although grain yield has undoubtedly increased, I thought the yield in 1994 was too high. Surprisingly, it became clear from a recent investigation of the Chinese Science Academy that statistics of cultivated area in China are 40% less than the actual amount. If we re-calculate the yield in 1994 with this actual area, it is about 3.2 tons. Even with the revised yield, it is at the same level as the average grain yield in Japan, America and Europe in the same year, which is very high. Water shortage is a serious short-term and long-term problem in China. The prices of such agricultural materials, as chemical fertilizers have started to increase rapidly from the early nineties, and will remain at high level in the future. Agricultural research investment has stagnated.[16] Consequently a continuous increase in the crops yield will be difficult in the long term. Superior farm land has been rapidly converted to nonagricultural uses because of the extremely rapid

economic growth, and the harvested area of grains has been reduced at an annual rate of 0.462% from the post war peak in 1976 to 1992, as described in the above section. Grain production (including soya beans) in China had increased at an annual rate of 3.42% from 130 million tons in 1950 to a mid-term peak of 407 million tons in 1984, and although it reached an historical record of 466 million tons in 1995, it has only increased at a rate of 1.27% annually from 1984 to 1994. The Chinese government raised the buying prices of the grains under the quota system from the farmers by 88% in July 1994, and by 20% in 1996 as well. However, these were still a long way off the free market grain prices. It is reported that many farmers stopped rice and grains production because of the government low buying prices.[17)]

Various factors can be considered for the recent rapid declines in the increase rates of global average grains yield and grains production. The grain yield increase in the green revolution was made possible mainly by the increased use of fertilizers. The world total fertilizer use started to fall from the late eighties, and it has continued to fall until the mid-nineties, and it is expected to be stabilized during the whole nineties.[18)] The effectiveness of chemical fertilizers in increasing the grain yield has decreased globally, and it was only one fifth as effective in the period 1984-89 as it was in 1950-84.[19)] This may reflects the exhaustion of our technical knowledge accumulated in the grain varieties. The global stock of agricultural technical knowledge, which in the past had been accumulated rapidly by high research investment and had resulted in the green revolution, has recently been exhausted because of the decline in the research investment.[20)] Investment for agricultural/rice research in Asia has been stagnated along with the rapid decrease in the global price of rice in real terms since the eighties.[21)] Also yields of rice and wheat have recently reached a plateau and it is feared that they are near the biological limits for rice and wheat. [22)] Shortage in agricultural water resource and gradual deterioration of the soil mentioned previously may also be factors for this. The recent stagnating grains yield and the significant reduction in the grains planted area as mentioned before brought stagnation or reduction in grain supplies, and the continuous

reduction in the global grain stock ratio.

What will be the global grains yield towards the 21st century? Although there are many different opinions, I believe that the agricultural technology used in the green revolution has a serious problem regarding its long term sustainability, as it must use substantial amounts of chemical materials, and continually develop new varieties to cope with diseases and harmful insects which quickly adapt to the latest agricultural chemicals.[23] However, there is no other way except using this technology for a while to cope with the fast increase in the demand for food during the peak period of population explosion in the developing countries until 2020. So we should modify the green revolution technology to minimize environment destruction until new appropriate technology is established.

Wheat, barley, sorghum and millets have larger area where yield improvement in difficult comparing with rice and maize under current agricultural technological conditions. Thus raising yield of the former grains will be more difficult.[24] However, some are of the opinion that the significant differences that exist in the grain yield among various countries or regions in the world show the possibility of adopting existing technology and increasing yield through increased use of chemical fertilizer, and at the same time decreasing the environmental damage and soil deterioration, especially in developing countries.[25] The difference in the yield, however, shows not the difference in potentiality in the existing technology, but the restrictions of the natural conditions on the yield in most cases as is clearly seen in the big difference between the yield of wheat in Western Europe and North America. As previously described, the growth rate of grain yield decreased significantly during the eighties, and yield of new high-yield rice varieties has been stagnating or decreasing in Asia. The harvested area of rice, 90% of its production and consumption are concentrated in Asia, has been decreasing as well. A 3% annual increase in rice yield will be needed to cope with the peak of the population explosion until 2020.[26] Although until now, the potential yield of various crops has been raised annually by 1~2% through the efforts of genetic

research,[27] a 3% annual increase in rice yield in the long term is very difficult.

How are such new technologies as bio-technology and hybrid varieties appraised for increasing grains yield? Since the appearance of hybrids corn in America in the thirties, the F1 vigor has been considered the break-through technology which would be the best means of increasing yields. But those views are too optimistic. Hybrid rice varieties have been planted principally in China (55% of the countrie's harvested area in 1992), because the high cost of hybrid seed production has been mitigated by cheap labor costs and the government subsidies, and it is said that the rice yield has only increased by 20%. Although the efforts have been made for the last twenty five years, hybrid wheat seeds haven't been successful due to the prohibitively high cost of seed production.[28] Although a significant increase in crop yield has been expected by using bio-technology utilizing gene transformation and gene mapping, virtually no useful result considerably increasing crop yield has been achieved so far. Many researchers understand that it takes several decades to extend new seeds developed by bio-technology among the majority of the farmers in the developing countries. Bio-technology is considered as an important means for genetic research, and it is recognized to bring graduate increase rather than bringing a brake through in yield.[29] IRRI in the Philippines plans to increase yield by 30% through developing 'the super rice'using bio-technology which has the plant type with 90 cm height of four or five short and strong stalks with big ears and eliminating stalks with no ears.[30] However, it is said that this has not been achieved according to Professor Horie of Kyoto University who has heard of the experiments with this rice in Japan.

4. Demand Factors

According to the estimates of the United Nations, population explosion which has occurred mainly in the developing countries after the war, will maintain the peak level during the period of 1990 to 2020. Population increases

annually from 90 million to 100 million during this period and the world population will reach to 8050 million by 2020 from 5300 million in 1990. The population in the developing countries will increase at the annual rate of 1.7 % from 4080 million to 6660 million during the some period. Population in Asia will increase at the annual rate of 1.64 % from 2900 million to 4500 million. The world population will double to 10,000 million by 2050. Grains (rice, wheat, barley, rye, corn, oats, sorghum and millets) will be the main source of the necessary calorie intake for the exploding global population and will be providing most of the calorie intake by the people in the developing countries which is 80% of the world total population in early 21st century.[31] The grain supply must rapidly increase during the period from 1990 to 2020 if it is to cope with the future explosion in the demand for grains caused by the population explosion and the fast economic growth in the developing countries and Asia.

Grain demand increases because of the increase in income as well as the population explosion. When per capita income increases in the developing countries, the immediate result is an increase in grain demand as food. An increase in the importance of animal protein in food consumption pattern as the developing countries grow, leads to increased demand for feed grains for the animals. According to World Bank statistics,[32] the per capita GNP in Asian developing countries has grown significantly, at annual rates of 3.0% to 6.4% during 1980 and 1993, compared to other developing countries who have experienced negative growth during the some period. The average per capita GNP growth throughout all developing countries was approximately 1% per year during the period from 1980 to 1993. The total GNP has grown at around 3.5% per year. This rapid per capita income increase, especially in Asia, brought significant increase in the demand for grains which is the staple diet of the people in the developing countries, and also rapid increase in the demand for animal protein in Asia, especially in China, resulting in explosive increase in the demand for feed grains.

Let's now investigate the actual situation for the rapid increase in grain demand within China. China has 22% of the world total population in 1990,

and thus she has a significant influence to future food demand. According to the UN estimates, although the Chinese population growth rate has been low (an annual rate of 0.9%) compared to the other developing countries due to 'the one child only policy' it has increased from 680 million to 1.2 billion during the period 1958-92, and will continue to increase to 1.5 billion by 2020. This rapid population increase will cause a rapid increase in her grain need. The economic reform which allows free decision by individual agricultural managements brought a rapid increase in grain yield and production in China in earlier years. The grain supply per person increased quickly from 230kg in 1961 to 354kg in 1995. However, it has remained static since 1985 due to the fast population growth, reduction of cultivated area and the slowdown in the increase rate of grain production as previously mentioned. Although the five year moving average of annual increase rates of grain yield has been increasing at an annual rate of over 5% during the period 1980-84, it fell to between 0.3%-3% afterword until 1992. This trend is likely to continue in the future.

The per capita GNP in China has seen super-high growth rate of 8.2% per year from 1980-93, and explosive growth rate of around 10% from 1992-95. This high economic growth in China will be maintained in the future as China has planned her economic growth rate at 7-8% until 2010 at the People's National Congress on March 5th, 1996. This recent rapid income increase brought a rapid increase in demand for meats, mainly pork which is the most popular meat for Chinese, at an annual rate of 10%. The grain prices have also rapidly risen through the explosion in the demand for feed grains reflecting the fact that the 4kg of grains required per kilogram of pork produced. Corn prices doubled within one year in 1995. The domestic free market rice price increased 3.2 times between January 1993 to June 1995 and it has became more expensive than the export price of the low grade 35% Thai rice which is almost equivalent to the domestically available rice in China from May 1994.[33] The Peking government prohibited the export of corn in November 1994 and soya beans from April 1995 to ease the domestic shortage. Grain exports from China (including soya beans) fell to almost nil in 1994 and 1995 as shown in Chart 4,

and the net imports rose to 15 million tons annually. Actually, the import of a large net volume of grains into China is not a recent phenomena, but it has been 10-20 million tons annually since 1977, except in 1985, 86, 92 and 93 according to the FAO data as shown in the same chart. According to a recent publication of the USDA[34], the Peking government was forced to consider the long-term demand and supply of food in China by foreign and domestic reasons in 1994 and 95 and conducted researches within some ministries and universities. Based on the research result, the government decided to change its food policy from long-held food self-sufficiency policy to 88 - 95% self-sufficiency policy. China consumes 112 million tons of wheat, 109 million tons of corn and 129 million tons of rice in 1995. An enormous amount of grain totaling 42 million tons annually (including 15.5 million tons of white rice) needs to be imported if the self-sufficiency rate is only 88%. Since the world trade markets in wheat and corn are thick meaning the total trading volume is large compared to the global total production, and the markets can manage the large import by China. But significant increase in the world rice trade price and confusion can be expected for the world rice trade market is thin meaning only 4% (15 million tons) of the world total production (White rice) is traded.

It can be concluded that the rapid increase that has occurred from the eighties until now in grains demand by the developing countries, represented by China and other Asian countries, has had the effect of reducing the global grain stock ratio.

5. The Effect of Agricultural, Forestry and Fishery Products Imports by Japan.

According to FAO statistics, Japan is the biggest importer of agricultural, forestry and fishery products in the world, and imported US$70.6 billion worth in 1994. Germany imported US$51.9 billion, France US$33.2 billion and Great Britain US$33.1 billion in the same year. Japan has behaved very differently

compared to these European countries regarding imports of agricultural, forestry and fishery products. The amount of these import by Japan was 5.6% of the total world trade value of these products in 1961, but had nearly doubled to 9.4% in 1994, whereas the same shares for France and Germany have not changed much and they have been around 6% and 10% respectively over the same period, and it for the Great Britain had reduced from 15% to 6%. The import value of these products in Japan increased thirty-fold from US$2.3 billion to US$70.6 billion from 1961 to 1994, whereas it for Germany increased twelve-fold from US$4.2 billion to US$51.9 billion. Japan has developed its economy by emphasizing more industrial production and export after the war in contrast to the European countries, and as a result she has neglected or depressed the domestic agricultural, forestry and fishery industries by increasing greatly the import of these products.

Prawn imports for example by Japan have been mainly from Asian countries, and in 1962 it was only 3,642 tons with a value of 2.2 billion yen, which was 46% of the total import value of fishery products, but by 1991 it had risen to 310,000 tons with a value of 412.9 billion yen, which represented 24.5% of the total import value of fishery products. The import volume of prawns increased 85 times during this period. Mangrove forest on the Thai and Indonesian coasts have widely been destroyed and substantially polluted by prawn farming for export to Japan. In another example, the import value of wood to Japan was US$930 million in 1967, and it rose to US$7.47 billion in 1990. Most of these were imported from the tropics (27% of the total import value of wood came from Malaysia and Indonesia in 1990) and it caused the destruction of tropical forest.

When Japan announced the official import of 2.5 million tons of white rice in September 1994 during the Heisei rice crisis, the rice trade price at the this world rice trade market doubled within four months in Thailand and America, and the retail and farm rice prices in Thailand and Indonesia increased between 7-30% within 4months.[35] Japan agreed to increase its import quota of rice from 4% of her consumption in 1995 to 8% in year 2000 in the Uruguay Round

agricultural products trade talks. The estimated effect on the international rice trade price of the emergency imports of rice after the Heisei rice crisis and subsequent rice imports under the agricultural agreement are estimated by the autoregrasion model and shown in Chart 5. Although the price fluctuates between 1993 and 2000, the estimated average rice trade price is about double of the 1992 price level. Consequently, the rice retail price in Asian countries may increase by about 20-30%. This will cause a crisis for the poverty stricken people (700 million in Asia out of the world's total of 1.1 billion) and for starving people (500 million in Asia out of a world's total of 800 million) in Asia as most of them eat rice as their staple food. The Japanese import of large amount of rice at any cost (price elasticity of import demand is small), will cause substantial increase in the instability in the world rice trade market price. For most of Asian people it is very important to live with the situation where stable and cheap rice price is assured. Japan should refrain from importing rice. Self-sufficiency in rice within Japan is important to the stability of rice price and supply in Asia, as well as in Japan.

6. Tightness of Grain Supply and Demand towards the 21st Century

As seen in the above analysis the world grain stock will be maintained at a low level in the long term as we head towards the 21st century, and the grain prices will increase, because of the transformation of the European and American agricultural policies after the late eighties, the restrictions on natural resources and agricultural technology, and rapid increase in the need for feed and food grains, principally in China, due to the population explosion and high economic growth.

7. Prospects of World Grain Supply and Demand for Year 2020, and the Needed Reforms in the Japanese Agricultural, Forestry and Fishery System.

Projected grains supply and demand in 2020 of the another are shown in Table 2 for the world, a group of countries classified by income level, China, India and Japan based on the above long term analysis of the world grain supply and demand. As regards the demand, the production conversion ratios from grains to meats and eggs are estimated based on the supply and demand balance data of the FAO for 1984-86 and expected long term increase in feed grain use in the livestock sector. The increase in the demand for feed grains is estimated by projected population growth rate, GDP growth rate and income elasticity of demand for meats and eggs. Medium estimates of the UN are used for the population and population growth rate. The FAO statistics were used to determine demand for meats, eggs and grains in 1993. As regards the supply, the growth rates of grains production, listed in the same table reflect the recent decline in the growth rates of grain production mentioned above.

There are two ways for a long term forecast of grain supply and demand. One is forecasting demand and supply independently such as the way used by me here and Lester Brown, and the other method incorporates the effect of the difference between supply and demand on the product price that is used by the World Bank, FAO, IFPRI and the Japanese Ministry of Agriculture, Forestry and Fishery.[36] Brown, the Ministry of Agriculture, Forestry and Fishery and I forecast that there would be a significant global grains shortfall in 2020 and/or 2030 and the prices of grains will rise, and others forecast that the world grain prices will decrease in early 21st century. The reasons for the different forecasts are basically differences in the assumptions for the projections reflecting the researchers experiences and values. Therefore it can be said that the long term

food forecast is an informed insight.

According to my projection, and I believe there will be an enormous grain shortfall of 320 million tons in developing Asian countries in 2020. The breakdowns are 170 million tons in China, 15 million tons in India and 417 million tons throughout the world. Although the high income countries export 172 million tons, that is far below the projected deficit in year 2020. This shortfall is significant, especially when one considers that the total world grain trade volume was 230 million tons in 1993. The reasons that such a significant grain shortfall are that the population explosion and high economic growth in developing countries, principally in China, will bring about a fast increase in consumption of animal protein, which will lead to an explosive increase in demand for feed grains, and that increase in grain supply will be restricted by limitations in natural resources and in the improvement of agricultural technology in the developing countries and maintenance of the agricultural policy transformation in Europe and America into the 21 st. century. The projection of a significant future shortfall by Brown is also for the similar reasons.

The estimation of significant grain shortfall by Brown and me will bring about a rise in the prices of grains in the world trade market. According to my forecast, assuming the long term price elasticity of the world grain supply and demand to be 0.15 (ratios between rates of change in supply and demand against the price change rate causing the changes in the supply and demand), the international grain trade price will increase by 50% compared to its 1993 level by 2020. This increase in the grain trade price will lead to considerable increase in the domestic price of rice and other grains and will cause significant difficulties to the huge impoverished people in the developing countries, who now numbers more than 1.1 billion, and will likely be large in year 2020.

A significant global shortfall of grains is forecast for year 2020 because of the long-run transformation in the European and American agricultural policies, the limitations in the natural resources and in the improvement in agricultural technology, and population explosion and fast economic growth in the developing countries which lead to fast increase in the demand for food and feed grains.

China and Japan will be important players in the long-term world food demand and supply situation. Large and continuous Japanese rice imports will raise and de-stabilize the rice price considerably throughout Asia which will result in the crisis for the huge Asian poor. The Japanese self-sufficiency ratio for grains is forecast to decrease from 28% in 1993 to 21% in 2020 as shown in Table 2 if the current Japanese agricultural policy is maintained. The Japanese import of agricultural, forestry and fishery products which increased after the war much faster them the European countries' import caused serious enphorization problems in inland and sea waters in Japan and also caused severe environmental destruction abroad as symbolized by Japanese shrimp import and tropical timber and wood imports. I believe Japan imports too much agricultural, forestry and fishery products as it causes serious environmental problems in Japan as well as in the developing countries, the crisis to the huge poor in Asian developing countries in the case of rice import, and serious concerns about food security and loss of external values derived from the primary industries by the Japanese because of the fast decline in the self sufficiency ratios for grains and other primary products. We should reform greatly and appropriately Japan's agricultural, forestry and fishery policy and their system emphasizing more domestic production of the agricultural, forestry and fishery products, including rice, which will lead us to higher self-sufficiency ratio of these products and to lower domestic and foreign environmental, social and external damages.

Notes

1) OECD, National Policies and Agricultural Trade, Paris: OECD, 1987, p. 52-53.
2) Ibid., p. 52.
3) Ibid., p. 56.
4) FOB import value is adjusted by the coefficient of 1.07 to be balanced with CIF import value.

5) FAO, Agriculture: Toward 2010, Rome: FAO, 1993.
6) Ibid.
7) Pierre Crosson, "Future Supplies of Land and Water for World Agriculture," Chapter 6 in Nurul Islam, ed., Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, pp. 154-156.
8) L. Oldeman, R. Hakkeling, and W. Sombroeck, World Map of the Status of Human-Induced Soil Degradation: An Explanatory Note, second ed., Wageningen, The Netherland; Nailobi: International Soil Reference and Information Center and United Nations Environment Programme, 1991.
9) World Bank and UNDP, Irrigation and Drainage Research: A Proposal, Washington, D. C.: World Bank, 1990; P. A. Oram and Behjat Hojjati, "The Growth Potential of Existing Agricultural Technology," Chapter 7 of Nurul Islam, ed., Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, pp.167-189, 1995.
10) P. Crosson, op. cit.
11) S. Postel, Last Oasis: Facing Water Scarcity, The Worldwatch Environmental Alert Series, New York: W. W. Norton, 1992.
12) L. R. Brown, "Future Supplies of Land and Water Are Fast Approaching Depletion," Comment on Chapter 6 in Nurul Islam, ed., Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, pp. 161-166, 1995.
13) Donald Duvick, "Plant Breeding and Biotechnology for Meeting Future Food Needs," Chapter 9 in Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, p.222, 1995.
14) R. Evenson and C. David, "Rice Research and Productivity," Chapter 3 in

Adjustment and Technology: The Case of Rice, Paris:OECD, pp. 57-84, 1990 and — Donald Plucknett, "Prospects of Meeting Future Food Needs Through New Technology," Chapter 8 in Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, p. 208, 1995..

15) Donald Plucknett, op. cit., p.208.

16) There is an opinion that Chinese grain yield will increase much more than now because of this underestimation and the comparison of yield with Japan, Britain and America. Zenpei Gen, "Structural Analysis of Chinese Food Economy and Supply and Demand Prospects", *Azia Keizai* , 37-2, February 1996, pp. 33-62.

17) USDA, ERS, Rice, Situation and Outlook Yearbook, p.13. Nov. 1995.

18) Balu Bumb, "Growth Potential of Existing Technology is Insufficiently Tapped," Comment on Chapter 7 in Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, pp. 191-205, 1995.

19) Lester R. Brown, Full House, Norton, 1994.

20) Evenson and David, op. cit., pp. 57-84, and Personal communication with Professor Takeshi Horie (crop science) in Kyoto University.

21) IRRI, 1993-95 IRRI Rice Almanac, Manila: IRRI, p.8, 1993.

22) IRRI, IRRI 1992-1993, Rice in Crucial Environments, Manila: IRRI, p. 8, 1993 and IRRI, 1993-95 IRRI Rice Almanac, p. 6.

23) Oram and Hojjati, op. cit., p. 168.

24) Oram and Hojjati, op. cit., p. 188.

25) Balu Bumb, op. cit., pp. 194-203

26) IRRI, 1993-95 IRRI Rice Almanac, p. 6.

27) Donald Plucknett, op. cit., p.208 and Donald Duvick, op. cit., p. 223.

28) Donald Duvick, op. cit., p. 223 and IRRI, 1993-95 IRRI Rice Almanac, p.110.

29) Donald Duvick, op. cit., p. 224-225.

30) IRRI, 1993-95 IRRI Rice Almanac, p.110.

31) IRRI, 1993-95 IRRI Rice Almanac, p.8.

32) World Bank, World Development Report 1995, pp.162-63.

33) USDA, ERS, Rice, Situation and Outlook Yearbook, Nov. 1995 §Ap. 13.

34) Ibid.

35) Hiroshi Tsujii, "International Effects of Emergency Rice Imports by Japan -the Crisis to the Huge Poor in the Developing Countries-", Kokusai Mondai, No. 416, pages 37-52, November 1994.

36) L. R. Brown, op. cit.; M. W. Rosegrant, M. Agcaoili-Sombilla and N. D. Perez, Global Food Projections to 2020: Implications for Investment, Washington, D. C.: International Food Policy Research Institute, 1995; Kym Anderson, B. Dimaranan T. Hertel, and W. Martin, "Asia-Pacific Food Markets and Trade in 2005: A Global, Economy-Wide Perspective," A paper commissioned for the International General Meeting of the Pacific Basin Economic Council, Washington, D. C., 20-22 may, 1996; D. O. Mitchell and M. D. Ingco, "Global and Regional Food Demand and Supply Prospects," Chapter 4 in Population and Food in the Early Twenty-First Century: Meeting Future Food Demand of an Increasing Population, Washington, D. C.: International Food Policy Research Institute, pp. 49-60, 1995.

Chart 1 Change in the Major World Grain Stock/Use Ratios

—Stock/Use Ratio of Each Crop at the End of the Crop Year—

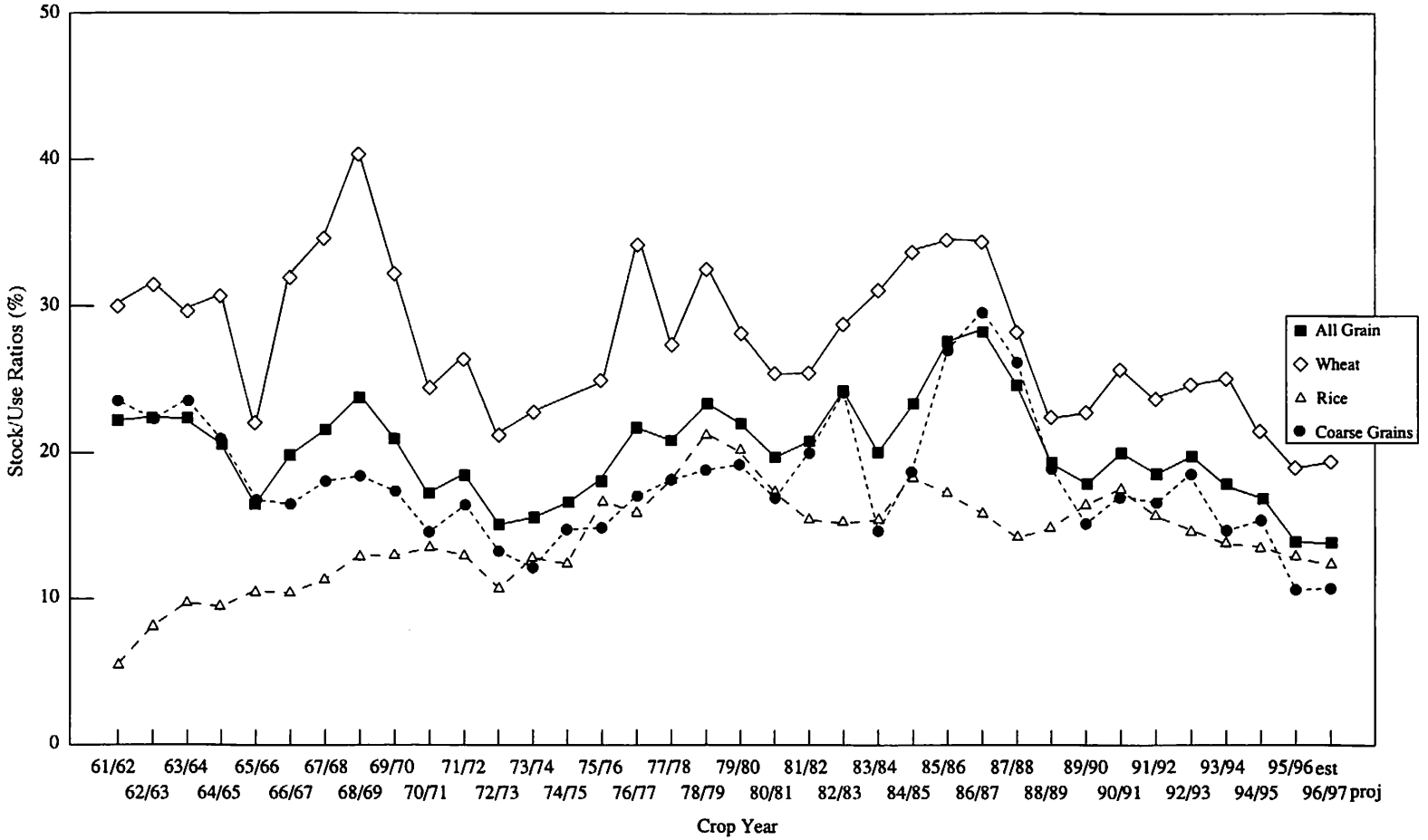
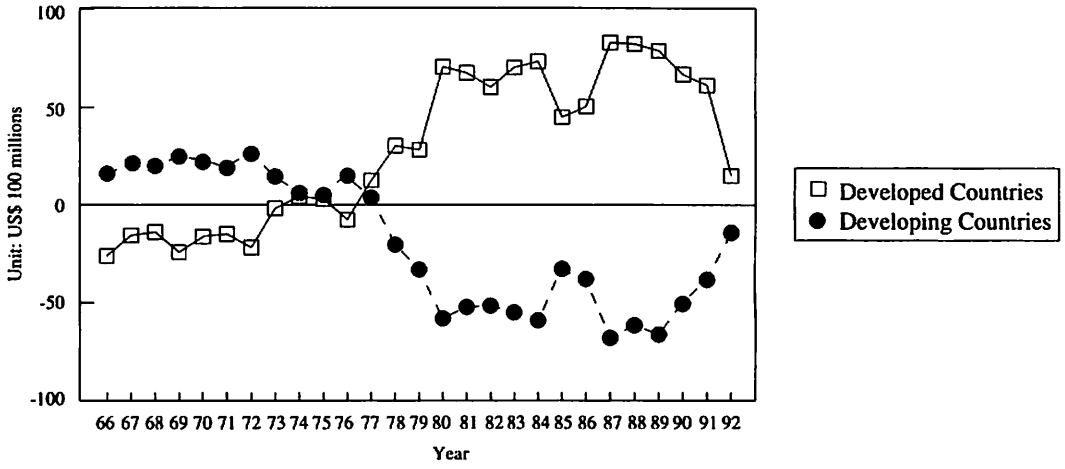


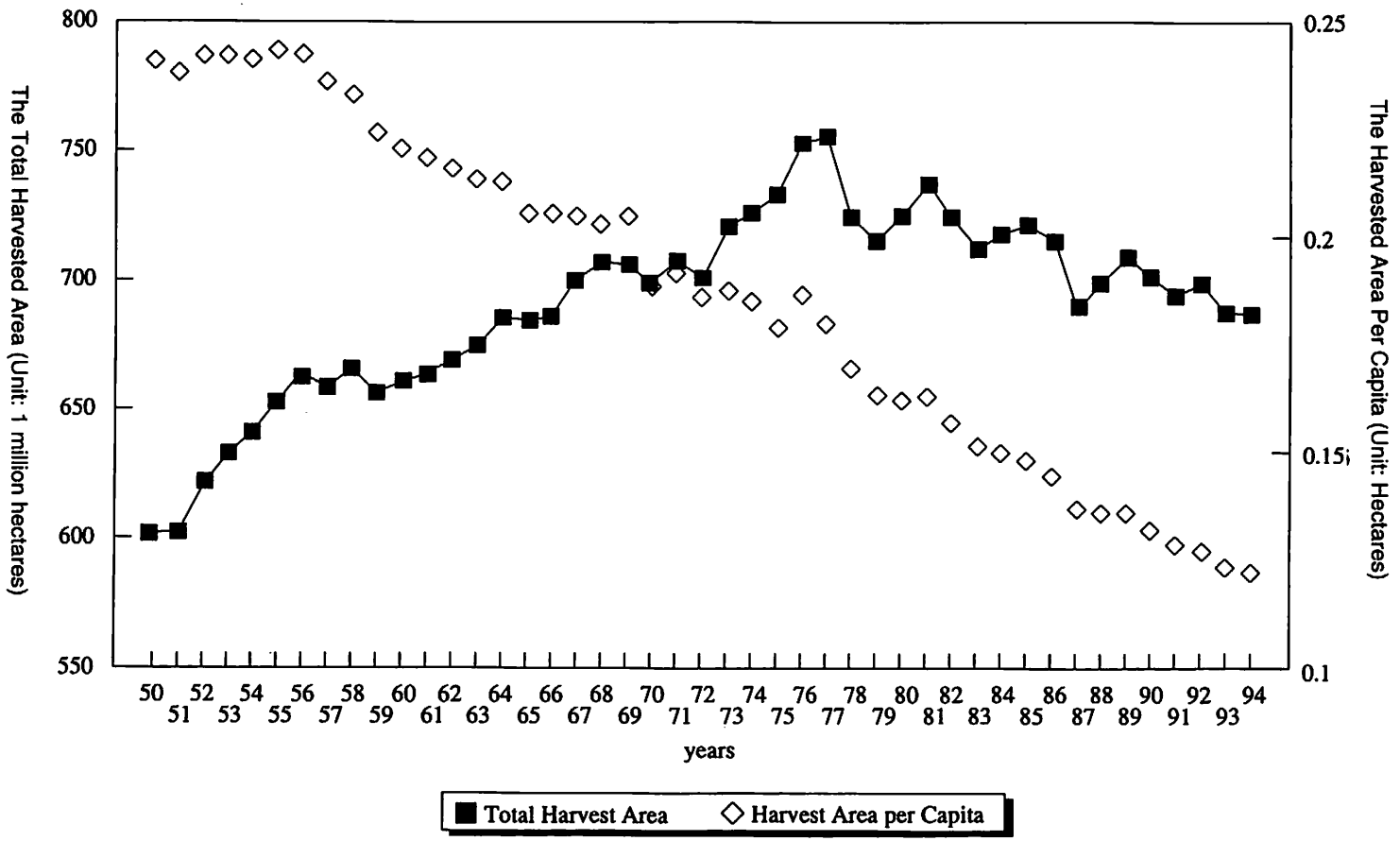
Chart 2 The Transformation in the North-South Food Demand and Supply Structure from the Last Half of the Eighties

— Real Net Food Export Value at the 1966 Prices —



Source : FAO Trade Yearbook

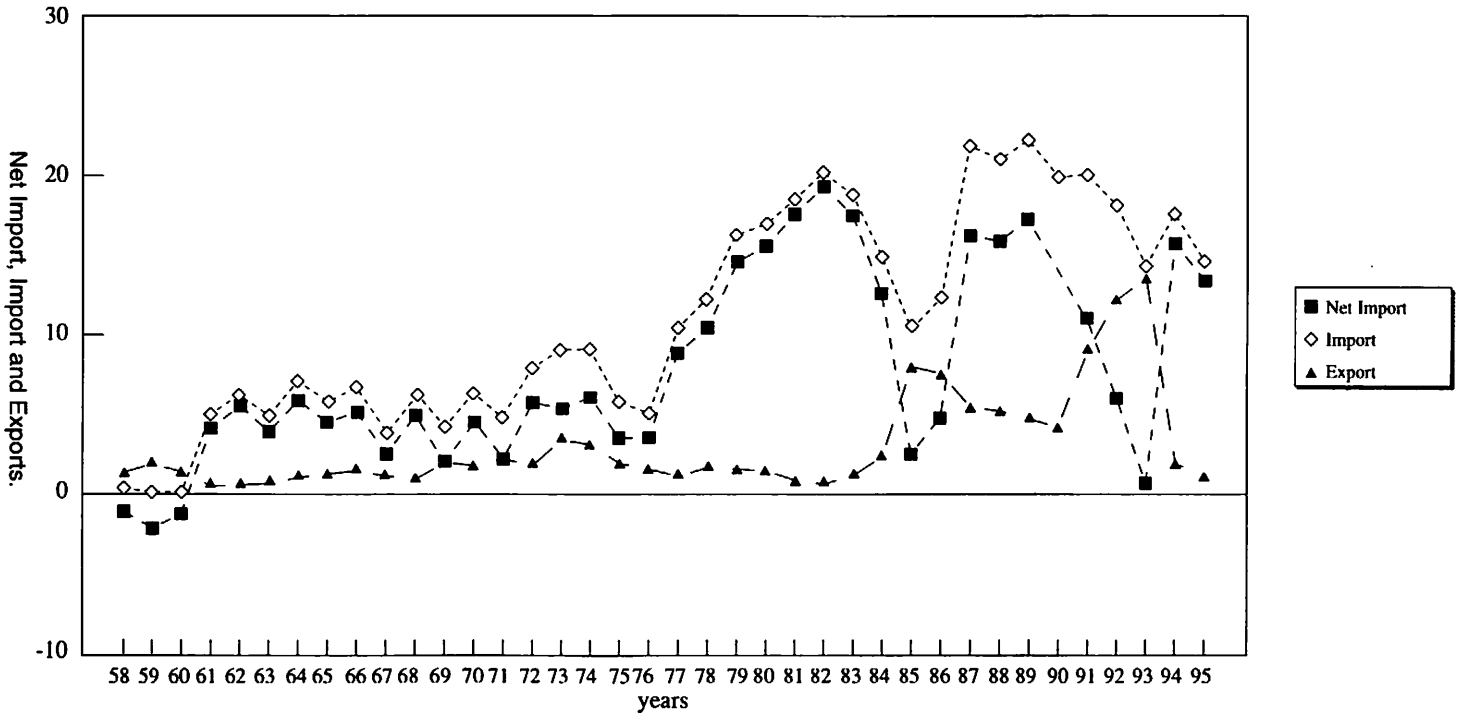
Chart 3 The World Total Harvested Area for Grains and the Harvested Area Per Capita



Note: Data mainly from FAO and from USDA for some data.

Chart 4 The Port-War Volumes of Grains Trade in China

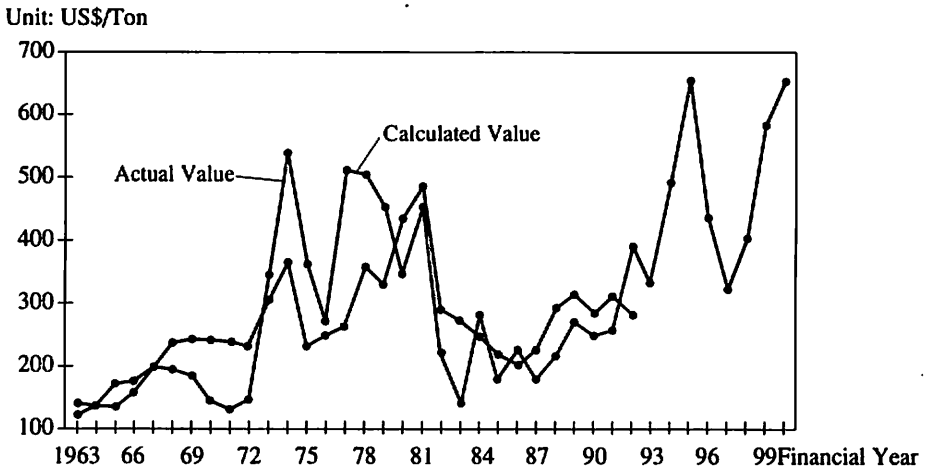
—Net Import, Import and Export.—



Note: Data mainly from FAO. Some incidental USDA data for recent years.

Chart 5 The Estimated Future Effects of the Japan's Emergency Imports and Minimum Access Imports of Rice to the International Rice Price

— by an Auto-Regression Model for 1993 ~ 2000 —



Note: Volumes of rice import into Japan is assumed to be two million tons in 1994, one million tons in 1995, and minimum access imports for 1996 - 2000.

Source: The actual value is the BTO's quoted export price of 5% rice in Thailand.

Table 1 Recent Large Declines in the Annual Growth Rates for Global Yield and Production of Major Grains

Unit: %

<Yield>	1966~74	1974~82	1982~90
Rice	1.94	2.42	1.78
Wheat	2.83	2.49	2.35
Corn	2.51	3.39	0.67
Sorghum	2.54	1.51	-1.00
Other Coarse Grains	2.07	0.57	1.25
<Production Volume>			
Rice	3.35	2.87	2.14
Wheat	2.82	3.23	1.76
Corn	3.55	3.78	1.23
Sorghum	2.17	1.05	-2.16
Other Coarse Grain	2.56	-0.05	1.16

Data: FAO, Production Yearbook (relevant annual issues).

Table 2 Projection of World Food Supply and Demand for year 2020 (For Edible Grains, Feed Grains, Meat and Eggs)

Demand Projection	1993			2020	
	Population (millions)	Consumption of Meat and Eggs Per Capita (kg)	Total Grain Demand (million tons)	Consumption of Meat and Eggs Per Capita (kg)	Total Grain Demand (million tons)
World Total	5522	39.50	1830	58.4	3269
Low and Medium Income Countries	4289	23.90	1072	58.4	2342
Developing Countries in Asia	3058	20.70	730	54.1	1473
China	1185	34.50	366	91.3	777
India	885	3.96	173	6.4	298
High Income Countries [a]	1228	93.10	767	100.0	927
Japan	124	47.80	40	52.8	42

Demand Projection	1993	2020	
	Grains Production (million tons)	Grains Production (million tons)	Excess Grain Demand (million tons)
World Total	1804	2852	417
Low and Medium Income Countries	930	1752	590
Developing Countries in Asia	675	1153	320
China	340	610	167
India	167	283	15
High Income Countries [a]	870	1100	-172
Japan	11	9	33

Note: (a) United States of America, Ex-Soviet Union, West and East Europe, Japan and Oceania.

Premises for the Projection of Supply and Demand

1993-2020				
Annual Increase Rates (%)				
Population	Consumption of Meat and Eggs Per Capita (kg)	GDP	Income Elasticity of Demand for Meat and Eggs	Estimated Conversion Ratios (grains/meat and eggs, amended by the FAO data) (%)
0.0141	0.01458	0.034	0.68	3.00
0.0164	0.03354	0.06	0.70	2.40
0.0147	0.03628	0.06	0.35	1.80
0.0089	0.03667	0.07	0.60	3.00
0.0152	0.01794	0.06	0.40	2.00
0.0045	0.00262	0.022	0.15	5.88
0.0014	0.00373	0.02	0.20	3.50

1993-2020
Annual Increasse Rates of Grain Production
0.0171
0.0237
0.0200
0.0152
0.0120
0.0087
-0.0081

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