

**STUDY ON
ECONOMIC DEVELOPMENT
OF
THE ARGENTINE REPUBLIC**

FINAL REPORT

Vol. II: JAPAN'S EXPERIENCE

JANUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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INTRODUCTION

Japan has about one hundred years experience of modern economic growth. At the initial stage of economic development Japan's per capita GNP was lower than the Asian developing countries' per capita GNP in the 1960s at constant prices. Japan's development experience is a typical late comers' one which is different from that of other developed countries. Most remarkable feature of Japan's modern economic growth is the acceleration of growth rate. This is called trend acceleration of economic growth. In the course of the accelerated economic growth, structural changes occurred in various fields and aspects.

In postwar period structural change in Japan was much more rapid than that in prewar Japan. Japan's economy changed its structure from light industry based to heavy and chemical industry based one in the 1960s when Japan enjoyed more than 10% economic growth. This rapid growth was facilitated by various factors such as rapid expansion of the world economy and stable supply of cheap energy and raw materials. After "oil shock" in 1973 Japan has made efforts to transform the economic structure to knowledge-intensive one. The features of these rapid structural changes in various fields are reviewed in the following chapters.

In Japan we have economic plans at various levels. These ranges from macroeconomic plans to sector plans such as industrial policies and land development plans. Major issues of these are described in the following chapters. These plans and policies are not rigid but indicative plans as mentioned the following chapters. Most important aspect of Japanese economic management is the coordination between private sector and the government. One of the major government roles in Japan is to reduce the risk of the future economic situation. It is very important to keep confidence each other for successful economic management.

In this report we reviewed Japan's development experiences and introduced economic plans and policies in various fields. Japan and Argentina are the two extreme countries as often mentioned. Japan is a resource poor country, but natural resources are fluently endowed in Argentina. Japanese people have the confidence in the future economic management of the government, but Argentine people seems to be suspicious to the government economic management because of the frequent change in economic policies. Due to the above-mentioned reasons, it is needless to say, all the Japan's experiences are not relevant to Argentine economic management.

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I . MACROECONOMY

I. MACROECONOMY

1. ECONOMIC DEVELOPMENT AND STRUCTURAL CHANGE IN POSTWAR JAPAN

After World War II, Japan made an effort to reconstruct its economy and establish economic self-reliance. Reconstruction was nearly finished by the mid-1950s. After establishment of economic self-reliance, Japan experienced high economic growth period (see Table I-1-1) and in 1968 it was ranked second in GNP among free economy nations following the United States. A comparison of GNP per capita shows how fast Japan has caught up with the United States in economic development (Table I-2-1). In 1950, GNP per capita in Japan was only 138 dollars, while being 1,882 dollars in the United States. In that year, the level of income per capita of the United States was 13.6 times that of Japan. The differential dropped by 1970 and the figure of the United States was only 2.5 times that of Japan. Furthermore, the Japanese GNP per capita exceeded 10,000 dollars in 1984, thereby the differential between the two countries was further reduced.

Table I-1-1 Average Annual GDP Growth Rate

	(%)	
	1960 - 70	1970 - 80
Japan	10.9	5.0
USA	4.3	3.0
UK	2.9	1.9
W. Germany	4.4	2.6
France	5.5	3.5
Korea	8.6	9.5
Argentina	4.2	2.2
Brazil	5.4	8.4
Mexico	7.2	5.2

Source: The World Bank, World Development Report 1982.

Table I-1-2 Per Capita GNP : Japan and USA

Year	(U.S. dollars)		
	Japan (1)	USA (2)	USA/Japan (2)/(1)
1950	138	1,882	13.6
1955	267	2,411	9.0
1960	457	2,803	6.1
1965	917	3,557	3.9
1970	1,947	4,841	2.5
1975	4,466	7,173	1.6
1980	8,907	11,558	1.3
1984	10,275	15,476	1.5

Source: IMF, International Financial Statistics.

Table I-1-3 shows basic economic indicators after the War. Economic development in postwar Japan is roughly demarcated into the following three stages. The first stage covers about 15 years from immediately after the War to the 1950s. In this period, great efforts were made in both public and private sectors in order to achieve speedy postwar reconstruction and economic self-reliance. In 1955, the GNP and index of industrial production exceeded the highest levels in prewar period for the first time after the War. In addition, Japan overcame the inflation that had afflicted the country since the end of the War, and had achieved self-reliant operation without foreign economic assistance or U.S. special procurement for the Korean War. Following the transition period in the second half of the 1950s, the Japanese economy began to sustain self-reliant growth, and entered the next high growth period through the "SURYO Boom (quantitative growth)" (1955) and "JINMU Boom (meaning the record high-growth in the Japanese history)" (1956-1957).

The second stage covers the high growth period from the end of the 1950s to the first oil crisis, during which Japan achieved heavy and chemical industrialization through a great structural change in its economy. During this period, which involved the "IWATO Boom (meaning the new record high-growth in the Japanese history)" (1959-1961) and "CHOUKI Boom (extended growth)" (1965-1970), the real annual economic growth rate climbed to 11.2% (based on GNP from 1960 to 1970 calculated at 1980 prices). After passing through this high growth period, the Japanese economy caught up with the economic scales and levels of the advanced Western nations as described above, and at the same time became free from the balance of payments deficit Japan had had for many years. In addition, the increased level of national income changed and diversified the people's sense of values. The high economic growth also accelerated concentration of the population and economic activities in industrial zones on the Pacific coast, resulting in economic and social distortion, pollution and environment problems. The Japanese economy, therefore, was required to change from quantitative to qualitative in its growth path and to fulfill the requirements for economic and social welfare.

The third stage covers the period from the first oil crisis to the present time. As described already, with the high growth period of the 1960s, the Japanese standard of living became higher than that of prewar period. Near the turn of the 1970s, Japan stood along-side the mid-range Western countries in terms of per capita income. But on the other hand strains and side effects of high growth were revealed.

As for the external environments, the factors for Japanese economic success in the 1960s has changed in the 1970s, beginning with the August 1971 "Nixon Shock", in which the United States executed a new economic policy featuring a halt to dollar-gold exchanges and a 10% surcharge on imports. Japanese yen exchange with the U.S. dollar soared rapidly. The oil crisis broken out in 1973 had strong impacts on the Japanese economy. It was hard hit by spiraling oil prices and, in 1974, registered the first negative economic growth since World War II. The oil crisis marked the end of Japan's high economic growth era, and annual growth of around 5%, or half the pace of the previous growth, became a permanent fact of life.

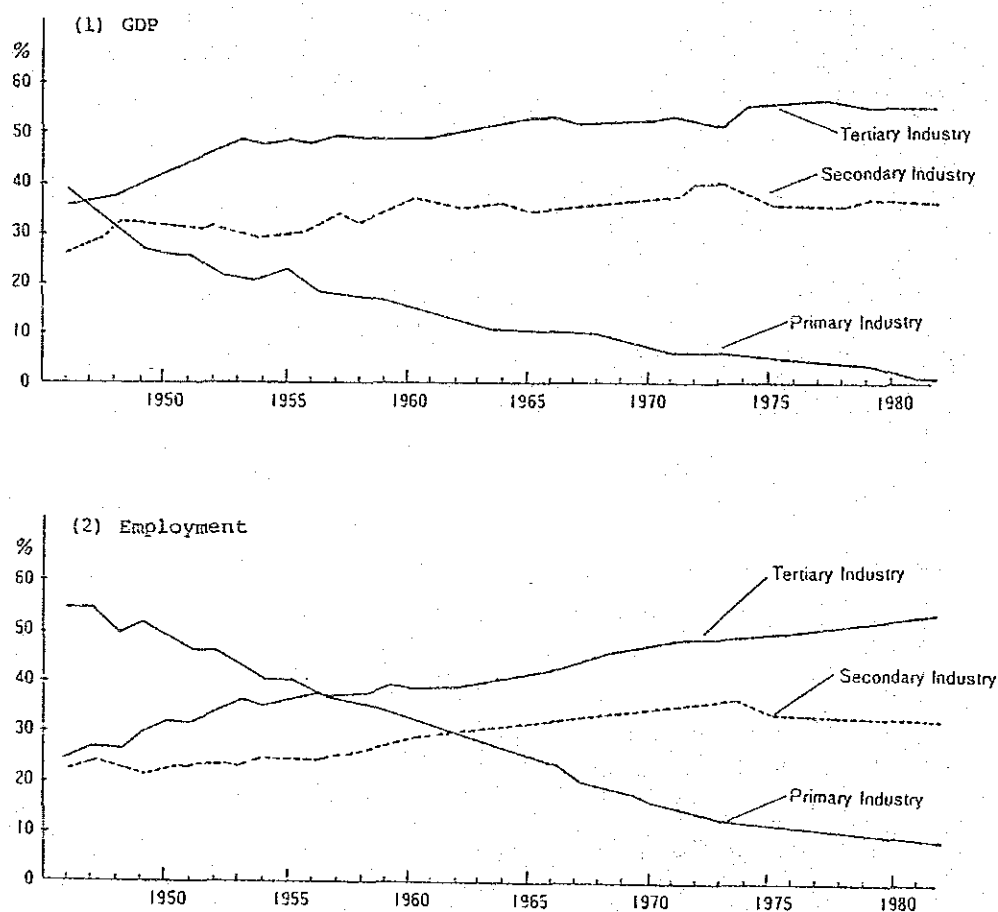
Table I-1-3 Basic Economic Indicators

	Reconstruction/Internal Consolidation Period		High-Growth Period		Transition/Stable-Growth Period			
	1946-50	1950-55	1955-60	1960-65	1965-70	1970-75	1975-80	1980-84
Population (million)	79.77	86.06	91.15	98.02	104.24	107.79	114.29	118.43
GDP (¥ billion)	2,419	6,503	11,555	23,704	50,612	106,807	96,350	265,353
Growth Rate (%)	9.4	7.9	8.5	11.2	11.3	4.7	5.1	4.2
Inflation Rate (%)								
Wholesale Prices	97.0	3.9	0.5	0.4	2.2	9.4	5.7	0.2
Consumer Prices	44.4	6.7	1.5	6.1	5.4	11.5	6.5	2.9
Investment Ratio (%)	25.1	22.8	25.9	31.8	33.2	34.5	31.5	29.7
ICOR	2.66	2.88	3.06	2.83	2.95	7.40	6.12	7.04
Trade Balance (\$ billion)	-0.19	-0.32	0.07	0.37	2.59	30.59	10.28	23.18
Economic Reconstruction	Economic Self-Reliance	Doubling National Income	Economic-Social Welfare					
		Trade Liberalization	Pollution					
			Environmental Problems					
			Capital Liberalization					
	Modernization	Sophistication	Industrial Structural Adjustment					
Basic Industries (coal, steel, power, shipbuilding)	Heavy and Chemical Industries	Knowledge-intensive Industries						

Economic adjustment was implemented to cope with these internal and external environment changes, and various measures were undertaken to achieve stable-growth in this period.

During such a course for economic growth, the Japanese industrial structure greatly changed. Figure I-1-1 shows the structural changes in the Japanese economy in GDP and employment since the War. Primary industry, consisting of agriculture, forestry and fishery, decreased significantly in both GDP and employment terms. On the other hand, the shares of secondary and tertiary industries increased approximately in parallel up until the early 1970s. After that the percentage of tertiary industry has been steadily increasing, while secondary industry has leveled off. As for manufacturing sector, the share to GDP increased over the period from the mid-1950s to the early 1970s. Its percentage rose from 23.2% in 1955 to 32.8% in 1973 and slightly dropped to 29.2% in 1983.

Figure I-1-1 Structural Change of Japanese Economy



Source: Statistics Bureau, Management and Coordination Agency, Japan Statistical Yearbook, various issues.

2. ECONOMIC PLANNING IN JAPAN

The purpose of this section is to discuss the role of planning in the economic development process in postwar Japan. For this purpose, the basic characteristics of Japanese economy and its relationship with the role of planning is discussed first. Secondly having this relationship in mind, the major characteristics and functions of Japanese planning are summarized. Thirdly, the planning process and the implementation of plans in Japan is discussed. This part is useful for understanding how in practice the above-mentioned functions are accomplished. Fourthly, an overall evaluation of economic plans during the last 30 years after World War II is made emphasizing especially the goals of the plans and their effects.

2-1 Basic Characteristics of Japanese Economy and its Relationship with the Role of Planning

The Japanese economic system is based fundamentally on free market mechanism and therefore private sectors are the main agents of economic activities and the assignment of resources is made through the market. Japan, as well as the United States and West European countries, is the country in which the efficiency and effectiveness of the free market economy have been demonstrated very clearly.

Nevertheless, for the following reasons, among others, it was necessary to implement the plans in Japan:

- (a) As a late-comer to the modern economic growth and industrialization, the country had to promote economic development in a significantly shorter period than the United States and major West European countries. This meant that the structural transformation took place very rapidly and consequently it was necessary to give the private sector certain guideline of what was going to happen in future.
- (b) It should be also mentioned that the availability of resources, especially natural resources as well as foreign exchange was scarce in Japan, particularly in the period immediately after World War II and therefore it was necessary to allocate the limited resources to the sectors of high priority.

2-2 Major Characteristics of and Functions of Economic Planning in Japan

Because of the above-mentioned relationship between Japanese economic system and planning, economic plans of the country have major characteristics described below.

First of all, they are normally indicative plans. They have different meanings for public and private sectors.

The foremost important task of plans is to show the general direction of government economic policy from the long-term viewpoint so as to give the basis for specific policies to be taken by each ministry and to guarantee consistency among them. For example, plans establish as one of their basic objectives the improvement of social overhead capital. The programs for different sectors and projects such as road construction, railroad construction, sewage construction, housing, etc. are prepared taking into account of the plans. If these programs are made independently, having in mind only the demand of each field, misallocations of resources, overheating or down swing in business trends, overinvestment or excess capacity to the demand, imbalance between costs and benefits to the nation would arise. The government economic plans therefore gives a consistent basis for these programs.

The second task is to analyze long-term problems of the economy and formulate the strategy to overcome these problems. As we will discuss it later, different problems were identified and analyzed in different phases of Japanese economic development when each plan was elaborated. They are, for example, recovery from the low economic level after World War II, expansion of employment, liberalization of the external sector, adaptation to the labor shortage, measures to avoid deterioration of environment, energy saving, structural adjustment, etc.

For the private sector, the task of the plan is to present a guide-post by showing the development process of the Japanese economy. When private enterprises make long-term investment plans, they have to consider the general business trend for the future. For them the plans can show the path and they can avoid confusion or bottlenecks. The plans are also intended to disseminate informations about the economic problems and the government economic policy to the public in general. This is the educational role of plans. The government is responsible for the realization of planned public expenditure but not for the behaviour of the private sector. Government contributes to the realization of the planned target for the private sector partly through this role of preparing the guide-post. As stated above, the plans anticipated the bottlenecks and setbacks that would emerge in the foreseeable future and enabled the nation to have a lead in taking necessary steps.

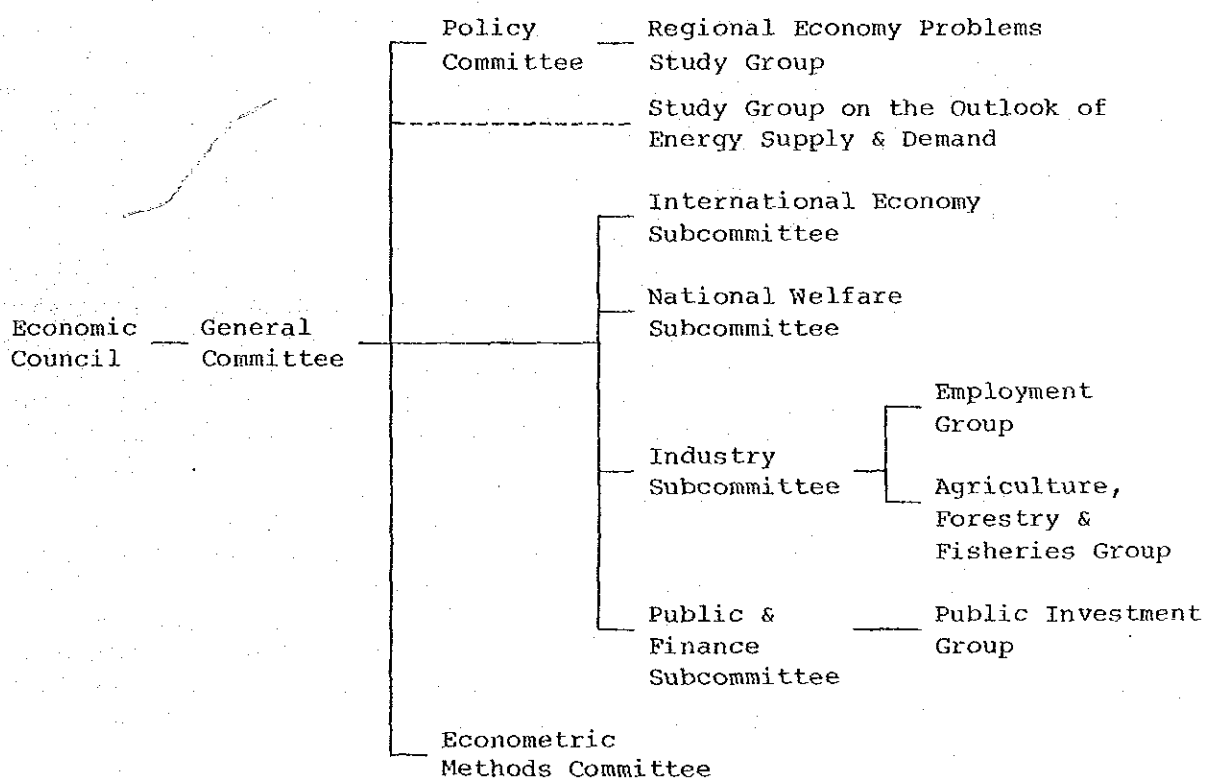
The plans also contributed disseminate macro-economic thinking among an increasing number of people and functioned as important vehicles to adjust competing interests and political commitment. Thus the coordination of interests among various social groups could be considered as another role of plans in Japan. The allocation of public investment is an example of this. At any rate, it is hard to deny the central importance of economic planning which has contributed in Japan to consensus building on, and increased participation in, the process of socio-economic development.

2-3 Planning Process and Plan Implementation¹⁾

2-3-1 Planning Process

The economic plan in Japan is drafted by the Economic Council upon request of the Prime Minister. The Economic Council is an advisory committee to the Prime Minister composed of learned and experienced persons. The Prime Minister indicates only the general purpose of the plan, and the Economic Council organizes the machinery for the drafting of the plan and after several months' discussion submits a draft of a plan to the cabinet (Figure I-2-1). The draft is adopted by the cabinet as the government plan almost without amendment.

Figure I-2-1 Organization of the Economic Council



Source: The Economic Planning Agency

1) This section is based on various documents of the Economic Planning Agency, Japanese Government.

In order for the plan to be effective, there must be a consensus on the plan not only among the cabinet members but also among government organizations and among various social groups. This consensus is reached in the process of plan formulation through various channels of coordination with various social groups.

(1) Coordination with the political party

As the plan in Japan plays the role of indicating the economic policy of the government, the plan must be consistent with the policies of the political party currently in power. The planning process begins with the inquiry of the Prime Minister to the Economic Council to draft a new plan. In this inquiry the general objective of the plan is shown. For example, the drafting of the current plan began with the inquiry by the Prime Minister to make a long-term economic plan for the realization of stable development of the economy and a richer national life while responding to long-term structural changes at home and abroad, in view of Japan's new role in the international economy and society. The Economic Council gathers at a general meeting two or three times and the Prime Minister attends every meeting. Before the final draft is sent to the general meeting of the Economic Council, consultations with the policy board of the government party are held and the comments by the policy board are considered in the final draft.

(2) Coordination among government organizations

In the process of drafting a plan, coordination among ministries takes place both explicitly and implicitly. Coordination among ministries is thought to be very important, because the Economic Planning Agency (EPA) is in charge of planning and coordination, and the carrying out of specific policy measures for the attainment of planned targets are left to other ministries. Another reason for this is that unanimous agreement of cabinet members is necessary for the draft of the plan to be adopted as the government plan.

Collaboration with other ministries is also necessary from a more technical viewpoint. EPA lacks knowledge or materials in special fields in which the ministries concerned have an advantage. Formal coordination takes place at the meeting of the secretary of each government organization. At the meeting, consultation is made by the Planning Bureau of EPA on the draft of the plan.

Then EPA gathers the comments and claims of other ministries, discusses and adjusts them into a consistent framework.

(3) Coordination with private sector

There is no official machinery for coordination with the private sector. Though members of the Economic Council belong to and are leading persons in certain social groups, they are not representatives of their groups, but experts in planning.

It follows that the role of the Economic Council is not regarded as the coordination of interests of social groups. Nevertheless, it is also

true that the opinion of a member reflects the opinion of the social group to which he belongs, and that the agreements made at the Council are expected to affect the decision making process of the group.

As the composition of the Council is not representative from this viewpoint, it is inadequate as a place for the coordination of social groups. Another channel to reflect the opinion of social groups is through the ministries concerned.

(4) Coordination with local governments

There is one chapter in the plan dealing with regional development. It is, however, an outline of the philosophy of policy and local government regards the plan as a guide-post set by the central government.

Regarding the plan on a regional level, there is a Comprehensive National Development Plan by the National Land Agency, which deals with national land utilization, location of industries and distribution of population on national land. In this plan the coordination with and among local governments plays the most important role.

Through the various channels of coordination stated above, a nation-wide consensus is reached on the general direction of development. In other words, the planning process is a process of formulating a consensus on the general direction of the national economy among various social groups. Each government body which is in charge of individual policies practices specific policy measures in line with the policy direction stated in the plan. Each private entrepreneur, who has to decide the direction of his enterprise, can make a decision in line with the general direction presented in the plan. As a result of their behaviour with proper macro economic demand control policy, the economic situation projected in the plan can be realized.

It can be said that the well-designed planning process guarantees the implementation of the plan.

2-3-2 Implementation of the Plan

Reviewing the history of economic planning in Japan, it is observed that actual economic performance exceeded the planned growth path, and that no plan has ever completed its plan period mainly because of this deviation. This fact suggests that there may be some problems in plan implementation. After the plan is approved and adopted by the cabinet, the responsibility for carrying it out is left to the administrative system. Legally EPA has the right to coordinate the basic policies and the practice of the economic plan. Also the Minister of EPA has the right to give advice to the heads of other government organizations for the promotion of the implementation of the plan.

(1) Machinery for the implementation of the plan

(a) Long-term plan and annual plan

The economic plan does not show the annual path to achieve the planned economic situation in the target year. Only the average growth rate and the general direction of the policies are shown. This implies that the annual practice of policies to achieve the goals in the plan depends largely on the annual economic fluctuations and also on the formation of the annual budget.

The Coordination Bureau of EPA submits an annual plan to the cabinet at the end of year, which presents the economic outlook and the basic philosophy behind the policies for the coming year. The budget for the coming year is based on the annual plan.

The annual plan does not explicitly mention the long-term or medium-term plan. There is no evaluation of past performance nor any evaluation of the coming year as an intermediate year of the plan. The annual plan is rather a forecast of private business trends on the basis of which the counter-cyclical measures such as fiscal or financial policies for the coming year are decided, under the existing international economic conditions.

In Japan the government budget is regulated by the single year budgeting principle under the Budget Act. There is no long-term budget plan. Though the policies of the budget to control total demand are based on the annual plan, the more qualitative aspects of the budget are based on directions stated in the economic plan, such as the allocation of government investment.

(b) Economic plan and ministerial plan

The long-term program for specific projects drawn up by each ministry must be in line with the government economic plan. Therefore, when a ministry makes a long-term program for a specific project, there must be consultation with EPA. However, as stated before, the plan is at such an abstract level giving only the general direction of economic policy, the plan period of the economic plan and the ministerial plans are not necessarily the same, and the implementation of the plan on a yearly basis is not mentioned in the plan, that a fairly high degree of freedom is given to the ministerial plan.

As for government investment on social overhead capital, the total amount spent in each field during the plan period, such as road construction, land development, or sewage construction, are determined in the plan. But the annual expenditure in these fields is not determined in the plan. The determination of annual expenditure rests with the annual budget. Each ministry claims a budget for the project of which it is in charge according to the long-term plan of the project which is made in line with the government economic plan. The final amount that can be spent on the project depends on the economic outlook for the coming year and expected government revenue. An unexpectedly high economic growth rate has sometimes necessitated the suppression of

government investment in order not to overstimulate the economy. The result is a reduction of social overhead capital relative to private direct productive activities. This was always the case before 1973.

The plan plays the role of guide-post for other governmental bodies in making their long-term programs for their specific projects, so as to eliminate inconsistencies among these programs.

(2) National plan and prefectural plan

The public sector of the plan consists of central government, local governments and government enterprises. The local governments do not participate in the planning process. In order to attain the goals of the plan the collaboration of local governments is indispensable. More than half of the government expenditure in the plan is the expenditure of local governments. The central government can control local governments to some extent through the allocation of subsidies. There is not, however, much guarantee of consistency between central government policy measures and those of local governments.

The only channel between central and local governments from the viewpoint of the long-term plan is the Comprehensive National Development Plan made by the National Land Agency. Each local government is obliged to make their long-term plan in line with the National Development Plan, which is formulated to be consistent with the economic plan. For example, the National Land Agency has worked out the Third Comprehensive National Development Plan in 1977. It is a plan for about ten years based on a long-term projection (a vision for the year 2000 of the relationship between the nation and national land).

(3) Economic plan and the private sector

The large deviation of the actual growth path from the planned path was mainly due to the divergence between the forecasts of private enterprises and the actual values attained. Also as stated before, the annual policies were not so deeply concerned with the achievement of the planned path. One reason for this was that the most of the deviations that occurred were upward. At that time, it was thought that the higher the growth rate the better, unless it did worsen economic imbalances such as the retardation of social overhead capital or inflation. The Japanese economy had behaved fairly well in these regards until the beginning of the 1970s. Most of the imbalances were solved in the course of rapid growth.

The experience of the last 4 or 5 years depression caused by the oil crisis, however, has shown that the rapid increase of demand causes resources shortage or inflation and dampens the economy.

Then it was realized that efforts to attain full employment given the constraints on natural resources or of keeping productive capacity in harmony with the international economy should be made.

2-3-3 Revision of the Plan

During the 24 years since 1955, Japan has had 9 plans which cover a total plan period of 52 years. This was because of the frequent revision of the plan. No plan has ever worked all over its plan period. This fact arises from the nature of the plan in Japan. As it cannot directly control the private sector, and as the private sector has no obligation to the plan, business trends often moved faster than planned. It cannot be denied that there was a tendency to underestimate private investment in order to achieve the target of the improvement of social overhead capital which was usually shown as a ratio of social overhead capital to private productive capital. This resulted in an upward deviation of the actual business trend from the planned path and caused the revision of the plan.

The second cause of revision was the divergence between the forecasts especially of world economic conditions and the actual values attained. Since the Medium-Term Plan, as econometric models have been used for the prediction of economic variables, there have been inconsistencies among the target variables. The main factor causing the deviation was the underestimation of world trade expansion. (There may have been an error caused by the misspecification of the model or an extra-polation error, but the second Report of the Econometric Committee for the Economic and Social Development Plan showed that they were not significant.)

The third cause is the change of cabinet. As the plan in Japan is rather a presentation of general policy directions than a detailed program of specific policies, the change of political philosophy of the cabinet (or of the Prime Minister) has sometimes necessitated a revision of the plan.

The fourth cause is lack of the effective supervision and evaluation system for the implementation of the plan. Effective machinery had not existed until the Basic Economic and Social Plan. The Economic White Paper prepared by the Research Bureau of EPA is a type of review and appraisal of economic performance, but not from the viewpoint of the achievement of the plan. Also the economic outlook and basic policies for the coming year prepared by the Coordination Bureau of EPA are not strictly coordinated with the implementation of the plan.

The Basic Economic and Social Plan was the first that stated that the plan should be followed up every year by the Economic Council and that the result of the follow-up study should be reported to the cabinet and that necessary remedial measures should be prepared.

Thereafter efforts to implement the plan has been made as an annual report of the follow-up study by the Economic Council.

The fifth cause of revision is unexpected remarkable changes of the situation at home and abroad. A typical example occurred in the case of the Basic Economic and Social Plan which was revised because of the unexpected down-swing of the economy caused by the oil crisis.

2-4 Major Goals of Economic Plans and their Effects in Postwar Japan

2-4-1 First Phase: Economic Reconstruction and Stability with Shortage of Basic Materials (from late 1940s to mid-1950s)

It is needless to mention that the most important goal of economic plans at the earliest stage of postwar period was the recovery from the damage of the War. It was also necessary to solve problems of extreme shortage of goods and high rate of inflation.

Therefore, the basic objectives of plans and proposals of this periods, among others, the Economic Reconstruction Plan (1949), Requirements for Realizing a Self-reliant Economy (1950) and the Three-year Plan for Economic Self-reliance (1951), were to attain quick economic reconstruction. They aimed at mobilizing and selectively allocating scarce resources in line with the national objectives of recovering the prewar standard of living and paving the way toward self-reliance, and laid down guidelines and justifications for the tight control over supply and distribution of goods, prices and wage rates, foreign exchange and trade, etc.

For example, the Economic Reconstruction Plan aimed to regain the 1930-34 standard of living by the end of 1953 and to provide necessary policy measures. The Plan laid special emphasis on the details of demand and supply of energy resources and other basic items because of the extreme shortage of them. It is highly important to mention that although a free-market mechanism was sought as the ultimate end, various direct controls on price and quantity of raw materials and foods, restrictions on private investment as well as direct control on imports were still regarded as effective measures for economic equilibrium and reconstruction.

2-4-2 Second Phase: Self-sustained and Accelerated Growth (from mid-1950s to late 1960s)

In the mid-1950s, the Japanese economy recovered its prewar level of production and a reasonable level of self-reliance. Therefore after the mid-1950s, policy-makers increasingly shifted their emphasis from the recovery and stabilization to the generation of self-sustained growth, largely independent of foreign aid and fortuitous expansions of the external demand. But at the same time, it was considered also necessary to overcome the fundamental weakness of the Japanese economy which became increasingly apparent in the process of rapid recovery and growth. It was judged crucial to formulate comprehensive economic policies in accordance with a long-term development perspective, and economic plans as embodiments of official medium- and long-term policy commitments were made subject to the approval and endorsement by the cabinet.

The first such plan was the Five-year Plan for Economic Self-support in 1955, to be closely followed by the New Long Range Economic Plan in 1957. The Doubling National Income Plan in 1960 and the First

Comprehensive National Development Plan in 1962 can be also classified in this category.

During the earlier 1950s, economic planning became more comprehensive and the specific plans identified during this period for the expansion and upgrading of basic industries and infrastructure, such as electric power, coal, petroleum, iron and steel, food, ports, national railways and communications, all fell in line with the strategies set out in the comprehensive plans. The former two plans called for the concerned efforts of the public sector, private firms and individuals in expectation of the improved standard of living and full employment, as envisaged in the maximally projected targets and prospects of development that were considered possible given the availability of productive factors and having in mind the constraints thereof. At the same time, the plans functioned as milestones to adjust excesses or shortfalls of actual economic performance, defined criteria to allocate resources to basic sectors like transportation and energy and provided the bases to maintain consistency and coherence in annual investment plans.

Among different plans prepared in this phase, the Doubling National Income Plan was acclaimed as the most successful, and became the model for subsequent economic planning. It proposed to double per capita income in ten years, gave a profile of the economy and the standard of living envisaged after ten years, and suggested specific policies necessary to achieve this ambitious goal. The plan was also known for its explicit commitment to catch up with the Western developed nations. The basic strategy of the plan was to accelerate economic growth by the stepped-up development of heavy and chemical industries, and to ensure by various policy measures that the effects of such growth stimulate the development of low-productivity sectors like agriculture and small and medium industries. This explicit and comprehensive approach to have all sectors contribute to and benefit from the process of rapid economic development ensured better structural integration of the economy and muster the entire nation's energy toward economic growth.

The Medium-term Economic Plan in 1965 had a character of the interim progress report for the Doubling National Income Plan, and while emphasizing continued rapid economic growth, also proposed policies to remedy imbalances and distortions created by growth.

2-4-3 Third Phase: Social Welfare, Environment and "Internationalization" (from late 1960s to early 1970s)

After the mid-1950s, the Japanese economy experienced an extended period of high economic growth and industrialization and its international standing was greatly improved. At the same time, however, the nation had to cope with rising consumer prices, excessive urban agglomerations, increased environmental deterioration, inadequate social overhead capital, and other imbalances.

Economic planning during the third phase which covers the latter half of the 1960s, therefore, emphasized, among other goals, the social aspects of development, as seen in the naming of the respective plans:

for example, the Economic and Social Development Plan in 1967, the New Economic and Social Development Plan in 1970 and the Basic Economic and Social Plan in 1973. These plans put more emphasis on price stability, improved social welfare, increased investment and expenditure in social infrastructure and the like than on investments for continued generation of rapid growth. Moreover, the plans stressed the need to open up the Japanese economy in response to the increasing global interdependence. They also aimed at building national consensus on how to cope with various important issues of Japanese economy, most notably the problem of environmental deterioration, which would necessarily involve difficult adjustments among competing interests and demands.

2-4-4 Fourth Phase: Saving of Energy and Resources and Establishment of Stable Economy and Society (from early 1970s to present)

The fourth phase covers the period after the 1971 "Nixon Shock" (discontinued dollar convertibility to gold and drastic revaluation of Japanese yen) and the first oil crisis in 1973.

Both Japanese economy and economic planning faced a crucial turning point, when the favorable international economic climate which had buttressed the rapid growth of the Japanese economy came to an abrupt end and suffered repercussions from the monetary crisis, oil crisis and food crisis in rapid succession in the early 1970s.

Therefore, the Economic Plan for the Second Half of the 1970s in 1976 and the New Economic and Social Seven-year Plan in 1979 probed way to cope with greatly changed external and domestic conditions, and proposed programs to adjust the economy to a stable and slower growth path. However, behavioral patterns and modes geared to rapid growth took time to change, although the economy had succeeded in saving considerably the consumption of energy in general and oil in particular, and the second oil crisis exacerbated the difficulty of structural adjustments.

The Economic and Social Prospects and Guidelines for the 1980s in 1983 noted the end of catch-up process, the shift from rapid to slow and stable economic growth and other relevant structural changes which economic planning must take into consideration, and tried a flexible uncertainty and emerging needs of the new era. As a result, the plan radically reduced quantified macro-economic goals and requirements, which had always served as common bases for more detailed planning and investment scheduling in the previous plans.

Table I-2-1 shows features of selected economic plans in postwar Japan.

Table I-2-1 Selected Features

	Five-year Plan for Economic Self-Support	New Long-Range Economic Plan	Doubling National Income Plan	Medium-Term Economic Plan
Date published	December 1955	December 1957	December 1960	January 1965
Cabinet at the time of plan approval	Hatoyama	Kishi	Ikeda	Sato
Plan period (fiscal years)	1956-60	1958-62	1961-70	1964-68
Economic growth rate				
- Performance prior to the plan	FY1952-55 8.6%	FY1953-57 7.3%	FY1956-60 9.1%	FY1960-64 11.3%
- Projection in the plan	FY1956-60 5.0%	FY1958-62 6.5%	FY1961-70 7.8%	FY1964-68 8.1%
- Actual performance plan period	FY1956-60 8.7%	FY1958-62 9.9%	FY1961-70 10.7%	FY1964-68 10.6%
Method for projection	Colm method (Labour x pro- ductivity)	Desirable balance chosen from 3 cases with different growth rates	Growth rate previously decided	Econometric model
Aims	Self-support of the economy; and full employment	Maximization of growth; improve- ment of national living; and full employment	do.	Rectifying imbalance
Major policy objectives	Modernization of production facilities; promotion of international trade; reduc- tion of depend- ence on import; and encouraging savings	Improvement of infrastructure; heavy-industri- alization; promotion of exports; and encouraging savings	Improvement of social overhead capital; improvement of industrial structure; and rectifying the dual structure of the economy and improvement of social stability	Modernization of low productivity sectors; effi- cient use of labour force; and qualitative improvement of national living
Important economic policies of corresponding period	1952 Member- ship in IMF and IBRD 1955 Member- ship in GATT 1953 First Modernization Plan for Steel Industry	1957 First 5- Year Develop- ment Plan for Japanese National Railways	1960 Policy guidelines for foreign exchange and trade liber- alization	1962 Law for Developing New Regional Industrial Cities 1962 First Comprehensive National Development Plan (Growth Pole Approach)

Source: Economic Planning Agency and others.

of Economic Plans in Japan

Economic and Social Development Plan	New Economic and Social Development Plan	Basic Economic and Social Plan	Economic Plan for the Second Half of the 1970s	New Economic and Social Seven-Year Plan
March 1967	April 1970	February 1973	May 1976	August 1979
Sato	Sato	Tanaka	Miki	Chira
1967-71	1970-75	1973-77	1976-80	1979-85
FY1962-66 10.0%	FY1965-69 12.7%	FY1968-72 10.4%	FY1971-75 5.1%	FY1974-78 4.0%
FY1967-71 8.2%	FY1970-75 10.6%	FY1973-77 9.4%	FY1976-80 a little over 6%	FY1979-85 5.7%
FY1967-71 10.9%	FY1970-75 5.9%	FY1973-77 4.2%	FY1976-78 5.7%	--
do.	do.	do.	do.	do.
Balanced and steady economic development	Construction of admirable society through balanced economic growth	Promotion of national welfare; and promotion of international cooperation	Realization of a richer national life and stable development of our country's economy	Shift to a stable growth path; enrichment of quality of national life; and contribution to the development of the international economic community
Stabilization of prices; improvement of economic efficiency; and promotion of social development	Improving economic efficiency from an international viewpoint; securing price stability; promotion of social development; and maintaining adequate economic growth and cultivating development foundations	Creating comfortable environment; securing a stable and comfortable life; stabilization of prices; and promoting international cooperation	Stability of prices and securing of full employment; securing of stabilized life and creation of favourable living environment; cooperation with and contribution to the development of world economy; and securing of economic security and fostering of grounds for long-term development	Attainment of full employment and stabilization of prices; stabilization and enrichment of national life; cooperation in and contribution to the development of the world economy and society; ensuring economic security and fostering the foundations for further development; and reconstruction of public finance and new monetary responses
1964 Official Membership in OECD; Convention into an IMF's article 8 nation 1965 Government deficit financing bonds	1971 "Nixon Shock" 1972 Law for Promotion of Industrial Relocation	1972 Floating Exchange Rate Regime	1977 Third Comprehensive National Development Plan (Integrated Residence Approach)	1983 Law for Accelerating Regional Development Based upon High-tendency Industrial Complexes

2-5 Coordination between Public and Private Sectors: Role of Councils in the Selected Fields

One of the features of economic management in Japan is the cooperation between the public and private sectors. Introduction here is the roles of the various councils in which the representatives of both the government and the people go hand in hand in formulating economic policies. The Economic Planning Agency, the Ministry of International Trade and Industry, and various other government organizations work out medium- and long-term plans and forecast the future. Every ministry and agency has councils as advisory bodies to its minister which participate in discussing and formulating these plans. Each of councils is attended by those representing the academic circles, industrial and financial circles, labor, the press, former government officials, etc., and serves as a place of determining the common denominator of the opinions of the various private sectors. These councils investigate and deliberate at the ministers' request or on their own initiative on future policies in their respective administrative areas. Some typical councils in the selected fields are introduced in this section.

2-5-1 Macroeconomic Plans

As stated in 2-3, the economic plan in Japan is drafted by the Economic Council. The Economic Council is an advisory body to the Prime Minister whose members are selected to represent the academic circles, financial and industrial circles, labor, the press, and former government officials, etc. It has a function to study the matters concerning important policies on the economy, and particularly those concerning the formulation of long-term economic plans. On the request of the Prime Minister, it organizes the machinery for the drafting of an economic plan. At present, the membership of the Economic Council is 26 (5 from universities, 7 from industries, 6 from financial institutions, 3 from labor, 3 from former officials, and 2 from other private sectors). When making up a plan, 200 to 300 extraordinary members are appointed. The Economic Council is divided into a steering committee which administers the entire council, technical committees, working committees, study groups, etc. to handle relevant fields.

The technical committees, working committees, study groups, etc. identify problems in respective fields, organize policies and make concrete policy recommendations, and the steering committee coordinates the recommendations, works out an economic plan according to priority, and makes a macroeconomic forecast. The Economic Planning Agency, which serves as the secretariat of the Economic Council, participates in the working-level activities of the Economic Council, and at the same time, coordinates the opinions of the Council members, the Cabinet, political parties, and associated government agencies in order to attain a consensus for the purpose of making the plan to be proposed by the Council truly viable.

2-5-2 Agricultural Policies

The Ministry of Agriculture, Forestry and Fisheries has some 20 advisory councils with which to confer on policy matters, including several councils established for the three agencies under its jurisdiction, namely, Agency of Food, Agency of Forestry and Agency of Fisheries. Among them, the Council of Agricultural Policy probably plays the most important role in relation to the Government's long-term policy orientation and planning.

The Council of Agricultural Policy was established by the Agricultural Basic Law promulgated in 1961 to report directly to the Prime Minister, the Minister of Agriculture, Forestry and Fisheries, and other related ministers. It consists of members not exceeding 15, who are selected from the private sector by their special qualifications and experiences in the matters that concern agriculture. The Agricultural Basic Law stipulates that the Council gives its recommendations to the Government on three major policy matters, namely, (1) the government's long-term forecasts on the demand and supply of food and agricultural products and its policy suggestions, (2) the annual report on agricultural conditions as analyzed and evaluated by the Government, and (3) the policies for price stabilization formulated by the Government in order to promote selective development of agriculture, rationalize the distribution of agricultural products, ensure adequate levels of income for farmers, increase the demand for agricultural products, stabilize the living standards of consumers, and so on.

The other councils are organized on more specific issues related to agriculture, forestry and fisheries, as shown below, and give their opinions to the Government as stipulated by the respective laws which define their functions.

- Compilation and analysis of agricultural, forestry and fisheries statistics and observations of conditions of their production
- Irrigation and drainage
- Agricultural mechanization
- Agricultural inputs (seeds, agricultural chemicals and animal feeds)
- Sericultural development
- Fruit development
- Livestock development
- Arbitration of fresh milk marketing
- Veterinary licenses
- Wholesale market
- Sweetening resources
- Price adjustments of rice and other major food crops
- Forestry policy
- Forestry management
- National forests management
- Coastal fisheries development
- Exporting fisheries development
- Pearl culture development
- Fishing adjustments

2-5-3 Industrial and Trade Policies¹⁾

Ministry of International Trade and Industry (MITI) is in charge of policies on international trade and industry. Needless to say, policies should be compatible with the true interests of Japanese people. In this sense, it is essential that when MITI plans various policies and measures, public opinions from various sections in Japan should be taken into account. Therefore, a number of councils have been set up as advisory bodies to the Ministry of International Trade and Industry. Many of these councils investigate and deliberate at the Minister's request or on their own initiative on future policies in their respective areas. Their findings are reported to the Minister and actual policies and measures reflect the recommendations and suggestions of the councils. In this way coordination between private and government sector has been realized in Japan. Legally, these councils are established as attached organs to the ministry under the provisions of the Ministry of International Trade and Industry Establishment Law, and provisions for such matters as the organizational structure of such councils are stipulated by laws and regulations which are closely connected with the respective councils. These councils are composed of experts who are best informed in the matters deliberated on by the respective councils, leaders in the industrial circles concerned, general consumers, leaders in financial circles, and experts from a wide stratum of society, such as labor union leaders, university professors, journalists and ex-government officials.

Major councils on the promotion of industry and trade are the following:

- Industrial Structure Council
- Industrial Technology Council
- Export and Import Transaction Council
- Export Inspection and Design Encouragement Council
- Export Insurance Council
- Industrial Location and Industrial Water Council
- Chemical Product Council
- Aircraft and Machinery Industry Council
- Data Processing Promotion Council
- Textile Industry Council
- Traditional Craft Industries Council
- Advisory Committee for Energy
- Small and Medium Enterprise Policy Making Council
- Small and Medium Enterprise Stabilization Council
- Small and Medium Enterprise Modernization Council
- Japanese Industrial Standards Council

Some explanation of the selected councils among them are given below.

(1) Industrial Structure Council

This council investigates and deliberates on the direction of long-term, basic policies concerning Japan's industrial structure. In addition, it is a comprehensive deliberative organ with a purview covering matters related to MITI's decision-making on important current policies.

1) Japan Trade & Industry Publicity, Inc., MITI Handbook, 1984, pp. 158-174.

At present, this council is aware of the need for Japan to formulate a desirable future vision for its industrial structure in light of the country's reaction, adaptation, etc. to its natural resource needs. The Council produces such a vision of the country's industrial structure every year in the form of a plan which is revised according to the pattern of a rolling plan (see Chapter III 1-2). Based on this rolling plan, the council deliberates and studies the question of what constitutes the most appropriate industrial structure policies.

This council includes the following committees: Coordination Committee, Leisure Committee, Investment Finance Committee, Manpower Development Committee, Goods Circulation Committee, Consumer Affairs Committee, International Economic Affairs Committee, Industrial Location Committee, Industrial Pollution Committee, Chemical Industry Committee, Iron and Steel Industry Committee, Machinery Industry Committee, Information Industry Committee, Textile Industry Committee, Paper and Pulp Industry Committee, Housing and Urban Industry Committee, Consumer Goods Committee, Ocean Development Committee, Aluminum Industry Committee, Industrial Water Policy Committee.

(2) Industrial Technology Council

This council investigates and deliberates on science and technology in mining and manufacturing sector. In specific terms, the Council studies such matters as the identification of tasks for research and development and the roles to be assumed by the public and the private sectors in Japan's conduct of its research and development activities, the ideal form which Japan's regional research institutes should take, the system and methods of implementation for Japan's performance of technology assessment, the methods for Japan to use in carrying out international cooperation in research, as well as many other similar matters. Furthermore, this council is responsible for deliberating on the management of Japan's system of large-scale research and development projects and on the nation's development of technologies for new forms of energy and for energy conservation.

This council has the following committees: Coordination Committee, Research and Development Committee, Technology Assessment Committee, International Research Cooperation Committee, National Development Program, Local Research Organization Committee, New Energy Technology Development Committee, Energy Conservation Technology Development Committee.

(3) Textile Industry Council

This council investigates and deliberates on the rationalization of Japan's fiber industries. In specific terms, the Council studies and gives necessary advice to the Minister on basic directions to be given to textile entrepreneurs in order to promote the structural improvement of Japan's textile industries pursuant to the Law on Extraordinary Measures for the Structural Improvement of Textile Industries. This council is also responsible for studying optimal textile industry policies for Japan to employ in the future.

This Council has the following committees: Coordination Committee, Supply-and-Demand and Trade Committee, Apparel Committee.

(4) Small and Medium Enterprise Modernization Council

This council investigates and deliberates on small business modernization. In specific terms, the Council investigates and deliberates, through its committees, on such policies and measures for small business as modernization programs and structural improvement plans.

This council has the following committees: Coordination Committee, Treasury Committee, Agriculture, Forestry and Fisheries Committee, Transportation Committee, Construction Committee, Welfare Committee, Business Conversion Committee, General Merchandise and Construction Materials Committee, Basic Industries Committee, Machinery and Information Industries Committee, Petroleum Committee, Substrate Small and Medium Committee, Guidance Committee, Technology Development Committee, International Affairs Committee, Retail Commerce Committee, Service Industries Committee.

2-5-4 Transportation Policies

The Ministry of Transport consults its councils as to what the transport administration and the transportation industry should be in future to meet the changes in the transportation environment. The councils are formed of members representing the academic circles, the various areas of industry, and experts in transportation problems, in order to reflect the opinions and ideas of the various interested sectors in them.

The councils study their assigned themes, and make recommendations, which are reflected in the formulation of various transport policies, plans and programs.

The councils operating under the Ministry of Transport are as follows: Council for Transport, Council for Transport Policy, Council for Transport Techniques, Council for Rationalization of Shipping and Shipbuilding Industries, Council for Maritime Safety and Seamen's Training, Council for Ports and Harbors, Council for Construction of Railways, Council for Civil Aviation, Council for Tourism Policy.

The Council for Transport Policy has its hand in the formulation of the long-term policies for the development of transportation facilities. Introduced here are the activities of the Council for Transport Policy as representative of all the councils attached to the Ministry of Transport.

In 1970, the Transport Minister requested the Council for Transport Policy for the first time after the end of World War II to study the policies for the development of transportation facilities. In the following year, 1971, the Council submitted a report on the comprehensive transportation system based on a trend analysis of the fast-changing socioeconomic activities. The report identified the problems associated with long-term transportation policies according to a stochastic analysis of future traffic demand with 1985 as a target year, and made recommendations in specific terms on what the transportation infrastructure development plans should be and how the

plans be implemented administratively to develop a comprehensive transportation system.

In 1980, the Transport Minister asked the Council to study the transport policies from the viewpoint that Japan's economy has been leveling off instead of continuing the high rate of growth experienced in the past. In response to the request, the Council submitted, in 1981, a report titled "Basic Direction of Comprehensive Transport Policy Based on Long-term Perspectives" in which the transportation problems identified for the 1980s were studied and the measures to overcome them were proposed.

The Council for Transport Policy is not an extraordinary one to be convened when it is necessary to make recommendations on a long-term policy, but has permanent standing committees including the Administration Committee, Information Committee, International Committee, Regional Transportation Committee, and Freight Traffic Committee, all of which investigate and study the matters in relevant fields regularly. In 1985, for example, the Administration Committee installed a long-term transportation demand study group for the purpose of studying the future traffic demand based on the current trends of socio-economic development, and the Information Committee studied the basic measures for information processing and networking for transportation industry in keeping with the rapid progress of socio-economic activities toward an information age. In 1985, the Aviation Committee was newly established for technical study of basic policies for the operation and management of Japan's civil aviation industry.

The Committee for Urban Traffic in Tokyo Metropolitan Area is now working to study the traffic aspects of the Tokyo Metropolitan Area in the 21st century in order to make recommendations on a plan for the development of traffic network led by rapid mass transit railway systems and on the measures for the implementation of the plan.

***II. BIOTECHNOLOGY DEVELOPMENT,
USE OF ELECTRONICS IN AGRICULTURE
AND
FISH FARMING IN JAPAN***

II. BIOTECHNOLOGY DEVELOPMENT USE OF ELECTRONICS IN AGRICULTURE AND FISH FARMING IN JAPAN

1. AGRICULTURAL BIOTECHNOLOGY DEVELOPMENT IN JAPAN

Introduction

Agricultural research has given mankind new and better ways to improve production, processing and marketing of agricultural products. Moreover, agricultural research is also responsible for solving problems in environmental quality and human nutrition. The purpose of research in agriculture is to assure an ample supply of safe and nutritious food at reasonable costs, while maintaining a sustainable production system. Japan is generally considered as one of the leading countries in certain areas of agricultural research, and one of the key characteristics is that research and development efforts on selected major crops have been conducted solely by the public sector institutions.

Despite its notable achievements, agricultural research in Japan is facing new problems today. These problems are challenging Japan's ability to meet the current and future needs. Some scientists are concerned that conventional technology alone may not be able to meet emerging domestic and world needs for the future.

Recognizing these constraints, the Japanese Government has started a number of new research programs for high technology development, in the hope that at least part of the problems the world is currently facing can be solved by such efforts. This section deals with the current status of Japan's agricultural research and development and its future plans for developing new technology.

1-1 Research and Postwar Agricultural Development in Japan

Japan is generally recognized as having developed a productive and efficient food system based on smallholder agriculture in postwar years. Research and development played one of the key roles in this process, but a number of other factors also contributed to Japan's postwar agricultural development. It is necessary to refer to such factors in order to discuss the contribution by research and development efforts.

Japan's postwar years began with extreme shortages of resources including food which were vital to the economic and social development. Most of the institutional/structural aspects of the present-day Japanese agriculture were laid down in the late 1940s and the 1950s, particularly during the period of the military occupation. The agricultural land reform in the late 1940s was the earliest, and probably the most important, restructuring effort in early postwar years. The reform reduced the area under tenancy from nearly 50% to about 10% of the total agricultural land, and smallholder owner-cultivators became the backbone of Japanese agriculture.

A series of policies and institutional measures were taken to encourage newly created smallholding farmers in their efforts to increase production, especially of paddy and to a lesser extent other food crops. Notably, the Promotion of Agricultural Improvement Act in 1948 led to the establishment of the national networks of research and extension work. The public sector research institutions were divided into national institutes comprising the National Institute of Agricultural Technology and seven regional experiment stations, on the one hand, and local experiment stations under prefectural governments which also functioned as hubs of local extension services, on the other.

Extension services were organized after the system developed in the United States, and comprised agricultural extension workers and home economics extension workers, whose number peaked at 10,968 and 2,350 respectively in 1960 and gradually declined to some 9,000 and 2,000 in recent years. Moreover, the Seed Act of Major Crops in 1952 contributed to establishing an efficient system for seeds multiplication and distribution of the varieties newly developed at public research institutions, while the Agricultural Mechanization Promotion Act of 1953 helped to establish a system for improving the standards of agricultural machinery suitable to the Japanese conditions.

In addition, the Land Improvement Act in 1949 greatly helped to raise the productivity of smallholder agriculture by facilitating irrigation and drainage development, soil improvement and conservation, land readjustments to consolidate fragmented lots, improvement of farm roads, and so forth.

Another important institutional factor which buttressed the postwar recovery and expansion of food production was the government monopoly system of procurement and distribution in major food crops that began in 1942. After the later half of the 1950s, serious supply shortages of major food crops began to ease, and the orientation of the system was gradually changed to guarantee producer prices, though with different formulas and to varying degrees depending on the crops, to ensure adequate income to farmers. This change in orientation was most clearly indicated in the Agricultural Basic Law promulgated in 1961. Especially with regard to rice, the government monopoly in procurement and distribution with price supports was retained, and is still in force to this day with some adjustments. This contributed greatly to the subsequent increase in rice production, while the production of such crops as wheat and soybean for which different formulas were applied declined rapidly along with increased imports.

The emphases and orientation of agricultural research and development efforts underwent some significant changes along with the rapid recovery and expansion of the postwar Japanese economy. During the early half of the 1950s, increased production of food, most notably of paddy, was considered top priority. Research and development efforts centered on developing high-yielding and cold-weather-resistant varieties of paddy, improved methods for growing strong paddy seedlings and timing their transplantation in order to prolong the period of vegetative growth, and then they were gradually geared to technology improvements for effective plant protection and application of chemical

fertilizers, in addition to the continued efforts to improve soils in less fertile agricultural land. Such efforts were buttressed by the strategy for industrialization, which gave high priority to the increased production of fertilizers and agricultural chemicals.

The Japanese economy entered the period of high economic growth from the late 1950s through the decade of the 1960s, and this functioned to alter the structure of Japanese farm management. A large outflow of population from rural communities to urban centers continued along with accelerating industrial development, and this depletion of agricultural labor gave strong impetus to further improvements in crop yields and farm mechanization, chiefly in the production of rice. Aided by the Agricultural Mechanization Promotion Law enacted in 1956 and other related measures, small machinery suitable to smallholder agriculture began to be used in paddy production. By 1963, for instance, 80% of the land planted to paddy was prepared by walking-type power tillers. Moreover, the growth of household income not only increased but diversified the domestic demand for food, such as livestock products, vegetables and fruits. The Agricultural Basic Law of 1961, for instance, explicitly emphasized the need for "selective expansion" in production of livestock products, vegetables and fruits, in addition to the need to raise the farmers' income and to reduce the growing income disparity between the agricultural and industrial sectors.

This change was accompanied by the restructuring of research organizations in the public sector. The agriculture, Forestry and Fisheries Research Council had been already established in 1956 to coordinate research and development efforts on national and local government levels and to facilitate more effective integration between research efforts and extension work. Subsequently in 1963, the public research organizations were reorganized into six national institutes (agricultural technology research, agricultural experiment, livestock experiment, horticulture experiment, tea experiment, and agricultural engineering) and seven regional experiment stations. To these were added, by the early 1970s, six more national institutes (plant virus research, tropical agriculture research, grassland experiment, food technology, vegetable experiment and fruit experiment) and the Institute of Agricultural Machinery which was jointly supported by national and local governments, farmers' organizations, and the farm machinery manufacturing and other related industries.

A number of new paddy varieties were developed and introduced by the reorganized public research institutions. During the 1960s, varieties which were high-yielding and required high levels of fertilizer application and plant protection were developed in accordance with different climatic and other natural conditions in various parts of Japan. From the later 1960s through the mid-1970s, when farm mechanization began to extend from land preparation and threshing to harvesting and transplantation of paddy, varieties of paddy with stout short culms and more tillers which were not only high-yielding and responsive to fertilizer application but more suitable for mechanized harvesting were developed and introduced widely. This was accompanied with concomitant changes in the methods of growing seedlings and other paddy farming operations.

Increased supply of fertilizers, agricultural chemicals, vinyl sheets and other labor-saving productive inputs from the 1960s through the mid-1970s also led to the expansion and productivity increase in livestock rearing and horticulture. Breeding efforts of better varieties and the diffusion of artificial insemination using frozen sperms, for instance, gradually raised the scale of operation as well as the level of productivity in dairy farming, coupled with the introduction of machinery such as barn cleaners, bulk coolers and pipeline milkers. Vinyl-sheet greenhouse horticulture with or without mechanical control devices expanded rapidly in various parts of the country, enabling the year-round supply of perishable vegetables and the off-season production of certain fruits.

At the same time, agricultural research and development began to face new problems during the 1970s. The oil crisis in the early 1970s, for instance, called for stepped-up efforts at developing resource-saving as well as labor-saving technologies in agricultural production. Moreover, intensive and continual mono-crop farming systems relying on heavy application of fertilizers and agricultural chemicals began to cause deterioration of soils as well as the environment. As a result, efforts were increasingly directed, for instance, to the rationalization and detailed standardization of fertilizer application depending on the local soil conditions and the development of efficient intermittent irrigation systems in the crop sector, or to the refinement and standardization of feeding requirements for animals in the livestock sector.

More importantly, the problem of overproduction of rice vis-a-vis the declining tendency in per capita consumption began to emerge since the early 1970s, requiring a basic reorientation in agricultural research and development in the public sector. Along with the policy of restricting the area planted to paddy, it became urgently necessary from the later 1970s to the early 1980s to develop new and viable farming systems for the efficient utilization of the paddy fields, by primarily introducing dryland crops. This requires comprehensive efforts to develop new technologies including irrigation and drainage, soil management, control of excessive soil humidity and so forth.

Moreover, unfavorable weather conditions seriously affected the harvests in the northern parts of the country consecutively during the early 1980s, coupled with significant declines of technical skill among producers due to the aging of the farming population and the increased proportion of rural households with non-agricultural sources of income larger than farming. Such occurrence highlighted the pressing needs to develop technically and economically stable and productive systems of farming in Japanese agriculture.

Under these circumstances, national research organizations have been undergoing another reorientation since 1980, when the Ministry of Agriculture, Forestry and Fisheries announced Basic Directions for Agricultural Policies in the 1980s. Specifically, priorities in research and development are now placed on the following directions.

- (1) Breeding of improved varieties and establishment of labor-saving, stable and productive systems of farming in land-based agri-

culture, such as rice, wheat, soybean, and fodder crops, including rotations of paddy and dryland crops for efficient utilization of paddy fields, and further improvements in entirely mechanized farming operations.

- (2) Productivity improvement in livestock herds through the effective methods for testing animal productivity, development and application of embryo implanting techniques, establishment of the year-round utilization of silage, and development of efficient livestock farm management systems.
- (3) Utilization and advancement of biotechnology to create new varieties and organisms, and to vastly increase the functions of plants and animals.
- (4) Efficient utilization of solar, geothermal, biomass and other new or underutilized energy resources, and development of energy-saving and labor-saving technologies for agricultural production.
- (5) Maintenance and enhancement of capabilities and functions of agriculture for national land conservation, such as soil and water resource development, and for environmental conservation, such as cleaning of air and water.

The following sections will discuss the significance of the ongoing reorientation in Japan's agricultural research efforts with major emphasis on biotechnology development.

1-2 Research Organizations and Biotechnology Development for Agriculture in Japan

Agricultural research is a systematic search of new ways for improving agricultural production and marketing. In most cases, production research is oriented to maintaining or increasing the productivity of agricultural resources. Marketing research is largely devoted to maintaining quantity and quality of products as they move to and through markets.

The goal of such agricultural research usually lies in how technology development can benefit both producers and consumers. Some research is increasingly devoted to such questions as environmental quality and human nutrition, where techniques of approach may somewhat differ. But on the whole, the ultimate goal is a more ample food supply at reasonable costs, while maintaining a sustainable production system and reducing the uncertainty of harvest.

1-2-1 Public Sector Research Organizations

Conventional agricultural technologies alone would fall short of challenges of meeting the present day requirements of food, feed and fiber. Agricultural research as a whole, therefore, has to play a pivotal role in developing a newer and better production technology matching

the needs of the time. The institutional framework of research and development in Japan has been undergoing significant reorientation in order to achieve the desired objectives. In 1983, the Ministry of Agriculture, Forestry and Fisheries (MAFF) reorganized and integrated its research and experiment organizations partly to promote biotechnology development.

The Ministry of Agriculture, Forestry and Fisheries currently has 14 National Agricultural Research Institutes and 6 National Agricultural Experiment Stations under the Agriculture, Forestry and Fisheries Research Council. The total number of research staff is 2,474 at the end of FY1985. The Agriculture, Forestry and Fisheries Research Council is the primary agricultural research organization at the national level and responsible for planning, coordinating, financing and formulating national research strategy.

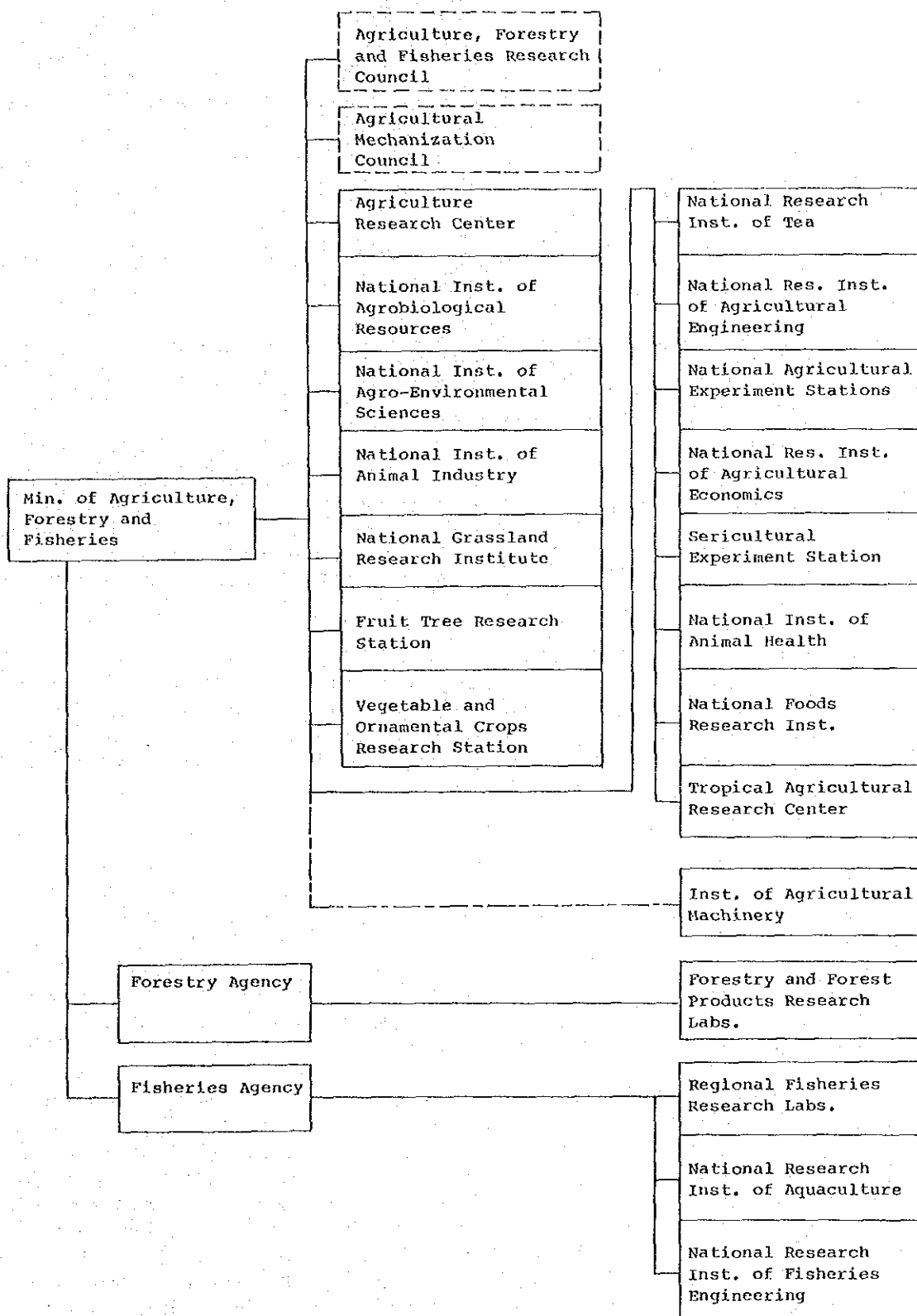
National Agricultural Research Institutes, shown in Figure II-1-1, are responsible for carrying out basic and developmental research in areas of national importance. The number of research staff totals 1,660 at the end of FY1985. National Agricultural Experiment Stations are responsible for technology development which is relevant to characteristics of each of the six regions in Japan. They are Hokkaido, Tohoku, Hokuriku, Chugoku, Shikoku, and Kyushu Experimental Stations. The total number of research staff at these stations are 814 at the end of FY1985.

Besides the above-mentioned national institutions, MAFF has a few institutes which specialize in forestry and fisheries research, as shown in Figure II-1-1. Forestry-related research institutes have a total of 508 research staff and fisheries-related institutes have 416 staff.

In order to develop agriculture, forestry and fisheries in its area of jurisdiction, each local government (mostly prefectural) has its own research institutions for technology development and extension services. The number of such research institutions totals 414, with 7,927 research staff. Table II-1-1 shows the number of public sector research institutions by area of specialization.

Most of the national research institutions and many prefectural research organizations engage in biotechnology development. For example, National Institutes of Agrobiological Resources, Agroenvironmental Sciences, Animal Industry and Animal Health, Fruit Tree Research Station, Vegetable and Ornamental Crops Research Station, Sericulture Experiment Station, Forestry and Forest Products Research Institute, National Research Institute of Aquaculture and some of National Experiment Stations located in six regions currently participate in programs and projects related to the creation of new biological resources by cell fusion and nuclear implantation. National Institutes of Agrobiological Resources and Animal Health undertake researches for identifying mechanisms of genetic expression in agrobiological resources, while National Institute of Agrobiological Resources, National Grassland Research Institute and National Research Institute of Tea have research projects for identifying physiological and genetic mechanisms of photosynthetic and respiratory functions. National Institutes of

Figure II-1-1 National Research Organizations in Japan



Source: Science and Technology Agency, ed., Indicators of Science and Technology, 1985.

Table II-1-1 Number of Public Sector Research Organizations
by Area of Specialization

Area	Agriculture	Animal Ind. and Health	Forestry and Fisheries	Others	Total
National	12	2	4	6*	24
Local	123	76	129	86	414

Source: Agriculture, Forestry and Fisheries Research Council,
Handbook on Research Related to Agriculture, Forestry and
Fisheries FY1984, Tokyo, 1985.

*National Agricultural Experiment Stations

Animal Health and Animal Industry, National Foods Research Institute, Forestry and Forest Products Research Institute and Tokai Regional Fisheries Research Laboratory conduct researches to develop new technologies for utilizing microorganisms and enzymes for biomass conversion.

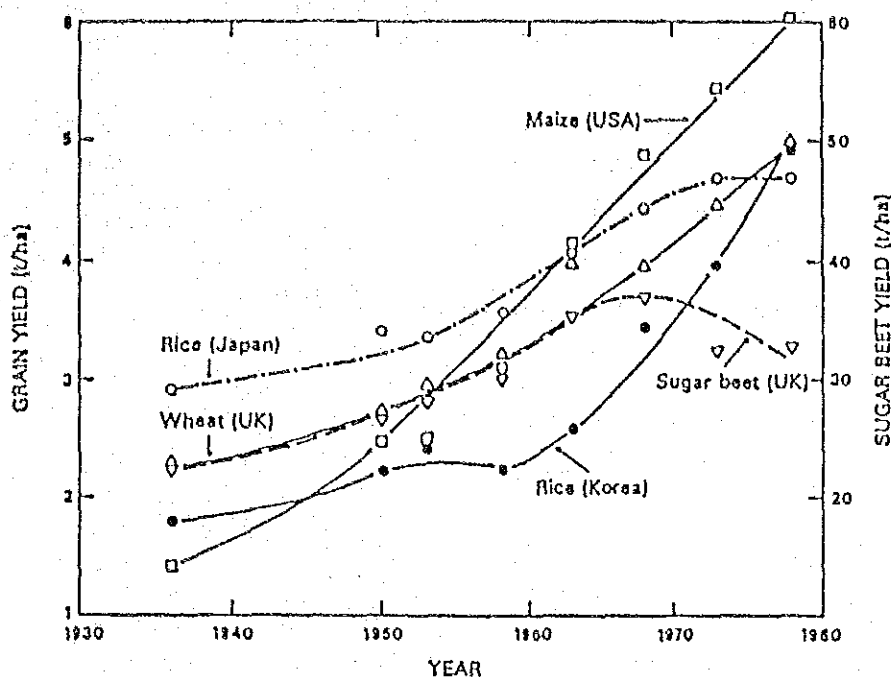
Out of the total 47 prefectures, 37 prefectures conduct research projects in cell culture to produce virus-free seedlings of various crops, and 36 undertake researches related to fertilized egg implantation of cattle. 26 prefectures have projects for mass multiplication of cell and tissue culture, 8 have projects for biomass conversion, 5 have projects for cell fusion, and so on.

1-2-2 Agricultural Biotechnology Development in Japan

In any program of agricultural research and development, it is important to take into consideration the progress of agriculture in a given region for which the program is specifically designed. It is important to realize that the foundations of what we call modern agriculture with its high levels of productivity were laid down less than 100 years ago even in the developed countries.

With regard to the development of crop productivity in Japanese agriculture, to take rice as an example, there was a significant gain in productivity during the years from 1950 through 1975, as shown in Figure II-1-2. This increase in productivity can be partly attributed to the yield improvement. The productivity after 1975, however, levelled off, not because of some technical impasse but because of economic reasons. Overproduction of rice vis-a-vis consumption in Japan worked against the introduction of high yielding varieties. Even under such circumstances, plant breeding efforts continued. Table II-1-2 shows the number of

Figure II-1-2 Changes in National Yields of Selected Crops



Source: Pleum, Genetic Engineering of Plants, 1983.

Note: Maize in the U.S.A. (\square), wheat (Δ) and sugar beet (∇) in the United Kingdom, and brown rice (paddy \times 0.8) in Japan (\circ) and the Republic of Korea (\bullet), based on averages for successive 5 year periods.

plant varieties developed by the National Research Institutes.

Search of new plant breeding technology also continued. Table II-1-3 shows selected achievements in biotechnology in the fields of agriculture and food in Japan. In 1968, the National Plant Virus Research Institute succeeded, the first time in the world, in isolating a large amount of mesophyll protoplasts from tobacco leaves by using enzyme. Leaf tissues are treated with pectinase and tobacco cells are disintegrated to individual single cells. These individual tobacco cells are then treated with cellulase to dissolve cell walls to form protoplasts. The protoplasts thus prepared can be easily infected by virus and are very important tools for plant virus research.

Furthermore, tobacco protoplasts are now playing another important role in plant breeding research. These protoplasts, when cultured under suitable conditions, undergo the process of division and propagation. The cells which continue to propagate develop into the original plant. It means that tobacco protoplasts can regenerate to whole plants. This important finding has provided the basis that protoplasts can serve as useful experimental materials not only for virus research but also for genetic and breeding research in plants.

Table II-1-2 Registered New Varieties Developed by Public-Sector Research Institutions (as of Nov. 1st, 1984)

Crops	Number of Varieties	Crops	Number of Varieties
Paddy rice	316	Onion	2
Dryland	53	Green pea	8
Wheat	129	Egg plant	2
Covered Barley	29	Mandarine orange	4
Naked Barley	29	Other citrus	5
Two-rowed Barley(for beer)	9	Apple	6
Oat	5	Peach	13
Maize	30	Pear	11
Soybean	80	Persimmon	2
Sweet potato	36	Chestnut	5
Potato	29	Grape	2
Groundnut	8	Loquat	1
Red bean	4	Tulip	13
Rape seed	44	Lily	4
Peppermint	11	Chrysanthemum	3
Mat rush	6	Alfalfa	3
Linseed	4	Italian rye grass	10
Cotton	9	Bahia grass	3
Beet	15	Orchard grass	5
Sugarcane	4	Timothy	4
Tea	34	Red clover	2
Mullberry	8	White clover	3
Strawberry	15	Sorghum	3
Tomato	20	Turnip (feed)	3
Bell pepper	1	Perennial rye grass	3
Cucumber	5		
Red pepper	3	Others	13
Melon	2		
Chinese cabbage	2	Total	1,074

Source : Agriculture, Forestry and Fisheries Research Council,
Handbook on Research Related to Agriculture, Forestry
and Fisheries FY1984, Tokyo, 1985.

Table II-1-3 Major Techniques in Agricultural Biotechnology and Selected Achievements in Japan (Public Sector)

1. GENETIC MANIPULATION

1-1 Genetic Recombination (recombinant DNA)

Selected achievements:

- Production of reverse transcriptase by yeast
- Development of binary vectors for plant recombinant DNA
- Determination of the entire base configuration of an attenuated virus of tomato and identification of the bases for attenuation

1-2 Cell Fusion

Selected achievements:

- Creation of fertile plant bodies from fused cells of cultivated and wild species of tomato
- Creation of plant bodies from fused cells of orange and trifoliolate orange (*Citrus trifoliata*)
- Regeneration of plant bodies from protoplasts of rice
- Differentiation and regeneration of hymenocarps from fused cells of heterogeneous strains of inky cap
- Creation of interspecific hybrids of tobacco
- Production of monoclonal antibody for swine influenza virus

1-3 Nuclear Transplantation

Selected achievement:

- Delivery of identical twins by artificial splitting of embryos (cattle and goat)
- Production of high-performance cattle by embryo transplantation
- Chimeric cloning of mouse and silkworm by embryo manipulation

1-4 Chromosome Manipulation

Selected achievement:

- Artificial development of females in fish species (carp, loach, flounder and rainbow trout)

2. CELL CULTURE

2-1 Cell and Tissue Culture

Selected achievements:

- Culture of immature ova of cattle and their fertilization by in vitro insemination
- Development of the method for creating primordia of asparagus shoots by liquid rotation culture

- Development of the method for mass culture of animal cells by floating microsome carrier (for production of vaccines)
- Production of virus-free seedlings of strawberry, garlic, carnation, etc.
- Culture of infectious equine anemia virus and development of the diagnostic method of infected animals

2-2 Anther Culture

Selected achievements:

- Development of intermediate mother plants and valuable strains of paddy
- Creation of high-yielding strains of strawberry

2-3 Embryo Culture

- Creation of a new vegetable "Hakuran" from cabbage (*Brassica oleracea*) and Chinese cabbage (*Brassica compestris*)
- Intergeneric hybridization of tomato and a wild *Solanaceae*

3. UTILIZATION OF MICROORGANISMS AND ENZYMES

3-1 Advanced Utilization of Microorganisms and Enzymes

Selected achievements:

- Development of the manufacturing method of isomerized sugar by glucose isomerase
- Discovery of a highly active raw starch splitting enzyme for energy-saving saccharification
- Development of a new method of producing cyclodextrin and its application for food processing

3-2 Bioreactors (enzymes and microorganisms for immobilization)

- Development of new methods of immobilizing enzymes and microorganisms by radiation polymerization
- Immobilization of cellulase by metal binding

Source: Agriculture, Forestry and Fisheries Research Council

Since plant protoplasts are cell-wallless single cells, they can be used as a system for introducing alien genetic materials into plant cells. In addition, hybrid protoplasts can also be formed by protoplast fusion. Since this finding, protoplasts have been isolated from various organs, tissues and cultured cells of many plants other than tobacco. It is expected that studies on the protoplasts derived from different species of plants will lead to the development of new methods and techniques for plant breeding, without resorting to sexual hybridization.

Generally, breeding of crops has to go through a number of stages: (a) to broaden genetic variability by means of crossing or mutation, (b) to select those which have useful characters, (c) to ensure hereditary stability to obtain uniform products, and (d) to produce a required quantity of seedlings. It normally takes a long time to complete the entire stages. With a view to overcoming this limitation and accelerating the breeding operation, efforts have been made to develop techniques to work on the cell basis.

Anther culture is a technique through which a plant can be obtained directly from pollen without fertilization. Theoretically, the technique can be applied to all seed plants. Normally, plants have two sets of chromosomes, but the plants originated directly from pollen are haploids which have only one set of chromosomes. However, they can be turned to homozygous diploids by treating them with colchicine or some other chemicals. This technique made it possible to ensure genetic fixation in a short period of one to two years, which otherwise would require many more years, thus contributing greatly to the progress of plant breeding.

Anther culture has been applied to the breeding of new varieties of rice as well as tobacco. It is well known that mutations often occur in a number of chromosomes, and it was found that very frequent gene mutations occurred in the case of rice. Because the frequency of mutations is comparable to that caused by irradiation treatments, cell culture is considered a useful method to produce mutants. As mutations occur frequently, selection of specific useful characteristics may be feasible by changing conditions for cell culture. Efforts have been made to select mutants for increasing environmental tolerance, photosynthetic capacity and useful ingredients.

It is important to ensure good and uniform seedlings for the purpose of increasing the productivity of vegetatively propagated plants. Since many vegetatively propagated plants are infected by virus, anther culture has been successfully employed to propagate, for example, virus-free strawberries.

As described above, techniques of cell and anther culture are expected to produce efficiently, and within limited time and space, new varieties which have such desirable characters as have been considered difficult to obtain by conventional breeding methods and techniques.

Some progresses have also been made in the area of animal industry. National Institute of Animal Industry and some local experiment stations have been conducting researches on so-called fertilized egg implanta-