

## Korea

### Agricultural and Fisheries Research Equipment Modernization Project

Report Date: September 2002

Field Survey: July 2001

#### 1. Project Profile and Japan's ODA Loan



Site Map: Suewon, Pusan and other cities



Site Photo: Aquaculture experiment with Aquatron (NFRI)

##### 1.1 Background

The economy of the Republic of Korea attained rapid growth in the 1970's led by the mining and industrial sector, and the per capita GNP increased by more than 500% in the 11 years<sup>1</sup>. Nonetheless, the performance in the agriculture and fisheries sector was comparatively stagnant. The share of the agriculture and fisheries sector in the national production decreased from 27% in 1970 to 18% in 1981, and the sector's share in the total work force likewise decreased in the same period from 51% to 34%. In addition, the percentage ratio of food self-sufficiency deteriorated, reflecting the diversification trends in food demands due to increases in the income level; the percentage ratio of food self-sufficiency went down to 54.3% in 1980 from 80.5% in 1970.

Accordingly, it was recognized that the strengthening of agricultural experiment and research, in particular, areas such as soil improvement, seed improvement or farming practice improvement be indispensable from the view point of contributing to the improvements in the productivity as well as to shifts in agricultural product composition in such a way to better accommodate the changes in food demands.

In the fisheries sector, while the catches in the pelagic fisheries had recorded continuous growing trends, the rate of growth in the total fish catch began to decelerate in the 1980's, due to the enforcement of the 200 nautical mile exclusive economic zones (since 1977) and the pollution in the coastal fisheries zones and, in some places, the loss of coastal fisheries zone itself. Given those constraints, the fisheries sector of the Republic of Korea was to mitigate the pollution and the occurrence of red tides (reddening of sea water because of eruptive proliferation of planktons), to carry out stock-taking surveys on the fisheries resources in the coastal fisheries zones, to ameliorate the environment of coastal zones used for aqua-culture, to improve fisheries product processing technology, etc. To cope with those challenges, the sector was deemed in urgent needs of experiments, surveys and researches.

##### 1.2 Objectives

The Project is aimed at promoting experiment and research activities and technological development in agriculture and fisheries sector, and thereby helping to foster improvements in agriculture and fisheries productivities through furnishing agriculture and fisheries experiment and research tools,

<sup>1</sup> GNP per capita increased from \$243 in 1970 to \$1607 in 1981.

machines and equipment, and ultimately contributing to the advancement in the agriculture and fisheries industry of the Republic of Korea.

### 1.3 Project Scope

The Project is to furnish 33 agricultural experiment and research stations, which suffer from shortage and obsolescence in tools, machines and equipment, with 387 kinds, and 16 fisheries experiment and research stations with 158 kinds of tools, machines and equipment.

### 1.4 Borrower/Executing Agency

The Government of the Republic of Korea / Rural Promotion Agency (RPA), National Fisheries Research Institute (NFRI)

### 1.5 Outline of Loan Agreement

Loan Amount/ Loan Disbursed Amount	3,300million yen/3,292million yen
Exchange of Notes/ Loan Agreement	June 1984/ August 1984
Teams and Conditions	
Interest Rate	4.75 % p.a.
Repayment Period (Grace Period)	25 years (7 years)
Procurement	General untied
Final Disbursement Date	March 1990

## 2. Results and Evaluation

### 2.1 Relevance

The Project was planned to promote research and development that laid the foundation for improvements in productivities in the agriculture and fisheries industry. The Fifth Five Year Plan (1982-1986) effective at the time of appraisal indicated the basic direction in the development policy for the agriculture sector; the target was set at agricultural structure reform, in which the funds allocated up until then for price support (subsidy) were to be transferred to investments in measures for improving the productivities and thereby bring about an increase in investments in agriculture with rational economic returns (or meeting the demands). As for the fisheries sector, it put focus on such policies as active development of fisheries resources, continual promotion of the pelagic fisheries, production technology development and enhanced extension of the developed technologies. Based on those basic policy directions, this project aiming at promoting research and development was judged to be in line with the economic development needs identified at the time of appraisal. The Government since then ceased to formulate five-year plans. Notwithstanding that, improvements in productivities and pursuit of economic returns are eternal themes underlining industrial renovations, and therefore, the directions in which this project is set to proceed still keep their relevance even in the present context of the agriculture and fisheries industry.

### 2.2 Efficiency

The Project was formulated so as to finance just procurement of tools, machines and equipment because the installment of procured goods was judged to cause no problems. The disbursement period was set to be five (5) years, and it actually took five (5) years to complete the procurement although the planned period for procurement was two (2) and half years. One contributing factor to the extension of procurement period was the time to examine and select the-state-of-the art tools, machines and equipment; it took more than expected. In addition, the determination of the executing agencies to utilize the loan fund to its upper limits became another factor that brought about that expansion; when assessing the availability of the loan fund, the executing agencies took into account the differences between Japanese Yen

equivalent amounts of the contracts that were designated in currencies other than Japanese Yen, and the actual disbursed amounts in Japanese Yen. The differences were due to exchange rate fluctuations. The executing agencies took advantage of the five (5) year disbursement period and literally used up the loan fund. It took five (5) years to complete the procurement, but it was recognized that the most of the procurement was more or less carried out according to the originally planned schedule as the disbursement records showed that the amount disbursed in the last two fiscal years (FY1988 and FY1989) amounted in sum to 510 million Japanese Yen, or only about 15% of the total amount of disbursement.

In the Project, tools, machines and equipment were planned to be procured giving due considerations to the priority<sup>2</sup> of each of the identified research themes, which was accorded in line with the basic directions indicated in the Fifth Five Year Plan. The procured items for agricultural research numbered in 1788 in 293 kinds (Plan: 387 kinds, about 2000 items) while those for fisheries research added up to 669 in 170 kinds (Plan: 158 kinds, about 400 items). Adjustments were made to the number of kinds and models as well as to the number of items according to specific needs of the research. For example, in the agriculture sector, tools, machines and equipment for livestock and veterinary science experiment and research were not included in the originally planned scope for procurement, but they were added to the shopping list. In view of the remarkably increasing trends in demands for livestock products, the expansion in the scope of the research areas to be financed was understood to be justifiable because the needs for research in livestock and veterinary science with such purposes as upgrading the capacity of livestock breeding or establishment of preventive and remedial techniques for contagious diseases among livestock were considered desirable from the view point of balanced development of agriculture.

As for the project cost, the actual total foreign currency cost was 3,292 million Japanese Yen as against the planned total foreign currency cost of 3,300 million Japanese Yen. The entire amount of the foreign currency cost was financed with the ODA loan<sup>3</sup>.

## **2.3 Effectiveness**

### **(2.3.1) State of utilization of research tools, machines and equipment**

More than 80 percent of items of tools, machines and equipment procured with the ODA loan exceeded their years of duration for economic uses, and they were disposed of<sup>4</sup> by the time of field survey. Consequently, it was not possible to obtain the information that could outline the state of utilization of the tools, machines and equipment. The aquatron in the picture on the first page is an example of those that are still in active use.

### **(2.3.2) Effects on experiment, research and development**

The use of the tools, machines and equipment deployed under the Project was judged to have contributed, to certain extent, to the enhancement of the efficiency in the experiment, research and technological development and to the quantitative expansion as well as the qualitative upgrading. Take a research area of marine environment for example. The deployed remote sensing multi-analysis system made it possible to draw a surface water temperature distribution map (4 million samples to be taken in the traditional method) of the coastal zones of the Republic of Korea just after receiving remote sensing data for only ten minutes. Automation in the experimental systems, speed-up in the analysis and upgraded

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<sup>2</sup> In the agriculture sector, 1) renewal of the obsolete, 2) those of the state of the art such as biotechnology, 3) those for basic research in such area as plant physiology, 4) those for applied research such as agricultural products processing were the order. In the fisheries sector, 1) those for technological development such as breeding, 2) those for technological development of products processing, 3) renewal of the obsolete were the order. Further more, in the fisheries sector, NFRI formulated "Vitalization Plan for NFRI" (March 1984: Report to the President) and it included 'Deployment Plan of Research Tools, Machines and Equipment.' The procurement was carried out with due regards for the Deployment Plan.

<sup>3</sup> At the time of the project formulation, inland transportation, installation, etc. were counted as local currency costs, and as a matter of fact, each of the executing agencies incurred those expenditures out of its annual general budget. Those expenditures, however, after more than ten years since the years of the expenditures, were not confirmable because the relevant books were disposed of.

<sup>4</sup> Refer to 2.5.1

degree of accuracy in experiments and experimental samples enhanced the efficiencies in experiment and research in terms of savings in labor, hours and materials. In addition, the enhanced capacity in analysis was realized on such substances as heavy metals, radioactive materials and residual agricultural chemicals. For example, newly deployed atomic photo absorptive photometer for heavy metal analysis contributed both to the quantitative expansion and the qualitative upgrading in the experiment and research because of the expansion in the range of analysis.

### (2.3.3) Number of research papers publicized and achieved technological developments

The research papers publicized and technological developments achieved by the researchers in the experiment and research stations of both executing agencies were counted in order to make a quantitative assessment of the effects of the deployed tools, machines and equipment on the experiment, research and technological development. As depicted in Table 1, the numbers of publicized research papers and achieved technological developments are increasing year by year in both of the sectors. In particular, NFRI relocated to the present place in year 1989, and the research environment was upgraded and enhanced. Together with such upgrading and enhancement, the fisheries sector has recorded remarkable increases in the numbers of papers and technological developments since 1989, the year of project completion, compared to those of 'before the Project.' The collected data in the agriculture sector are limited to those after the project completion; nonetheless, the data reveal constant increasing trends in the numbers of publicized research papers and achieved technological developments.

**Table1: Number of research papers publicized and achieved technological developments**

		1983	1984	1985	1986	1987	1988	1989 ompletion	1990 (2 <sup>nd</sup> year)	1991 (3 <sup>rd</sup> year)
Research papers	Agriculture	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Fisheries	25	22	41	42	26	51	71	47	71
Technological developments	Agriculture	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Fisheries	6	6	6	7	7	9	12	6	8
		1992 (4 <sup>th</sup> year)	1993 (5 <sup>th</sup> year)	1994 (6 <sup>th</sup> year)	1995 (7 <sup>th</sup> year)	1996 (8 <sup>th</sup> year)	1997 (9 <sup>th</sup> year)	1998 (10 <sup>th</sup> year)	1999 (11 <sup>th</sup> year)	2000 (12 <sup>th</sup> year)
Research papers	Agriculture	n.a.	n.a.	333	395	429	593	1,046	843	n.a.
	Fisheries	84	103	31	80	88	119	155	175	112
Technological developments	Agriculture	n.a.	n.a.	390	414	327	425	538	716	n.a.
	Fisheries	6	12	11	11	8	3	11	7	18

Sources: RPA and NFRI

Both RPA and NFRI have let, all this while, researchers go abroad for study and training and have made other efforts for promoting experiment and research activities; therefore, not all the accomplishments shown in the above table can be attributable exclusively to the Project. It can be concluded, however, that the Project played a catalytic role in, or was at least a part of the consorted efforts made for inducing increases in the investments in research and development, which brought about notable achievements as in the table above. NFRI also reported the numbers of patent applications and registered patents in the fisheries sector; in 1983, two (2) patent applications were made by NFRI and two (2) patents were registered. Those numbers increased substantially over the years; in year 2000, patent applications were 58 and 28 patents were registered. In addition, the number of researchers of NFRI who carry doctorates increased from 3 in year 1983 to 149 in year 2000.

## 2.4 Impact<sup>5</sup>

### (2.4.1) Impact on agricultural production

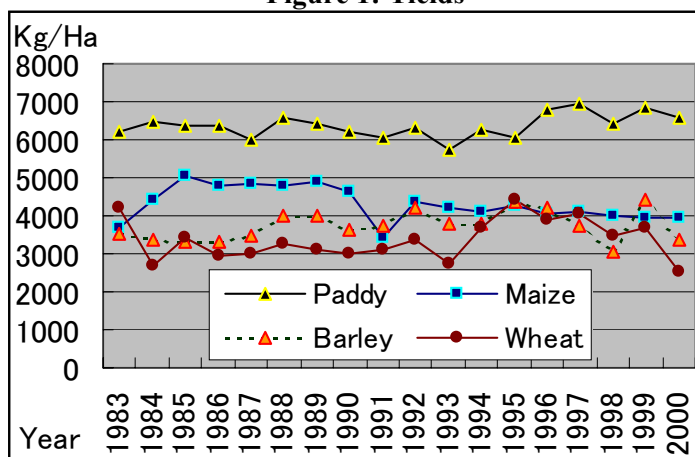
The Project sets two project goals: 1) improving the productivities of the agriculture and fisheries industry and 2) contributing to the development of the agriculture and fisheries industry through the promotion of research and survey activities in the agriculture and fisheries sector. The following is the outline of the impacts of the Project in those respects.

#### (2.4.1.1) Improvements in the productivity

##### a) Yields

Figure 1 shows trends in yields of major crops as indicators for improvements in the productivity. Major grain crops such as paddy, barley, or maize sustained the levels of yields.

Figure 1: Yields



Source: FAO Statistical Database

over a 16-year

##### b) Labor saving

Another indicator for improvements in the productivity of agriculture is saved hours of labor. In the Republic of Korea, the agriculture labor force was 10.8 million in year 1983. The number decreased by about 60% over a 16-year period from 1983 to 1999 and went down to 4.3 million in 1999. In spite of that drastic reduction in the workforce, the yields and the levels of production were kept constant as referred to in the following section; thus, the agriculture sector successfully achieved savings in labor inputs. One direct factor that explained such an achievement was mechanization in agriculture. The number of tractors used in year 1983 was less than 10,000. In year 1999, tractors being used numbered in about 180,000; the annual rate of increase was about 20 %. The numbers of harvesters and threshers increased likewise over the same period. Investments in physical facilities and machinery and equipment is easily observable as a factor contributing to increase production; but the key to the success in such modernization of agricultural machinery is a combination of improved conditions of farm land that allow farm mechanization and improvements in farming technology. Agricultural statistical books rarely succeed in recording innovations in farming technology and therefore they are easily left unnoticed. It is RPA that supported the innovation in farming technology through experiment, research, technological development, and among others, technology extension. If the things are viewed in such a way, the Project is recognized to have contributed, to a certain extent, to laying the foundation for improvements in labor productivity of the agriculture sector.

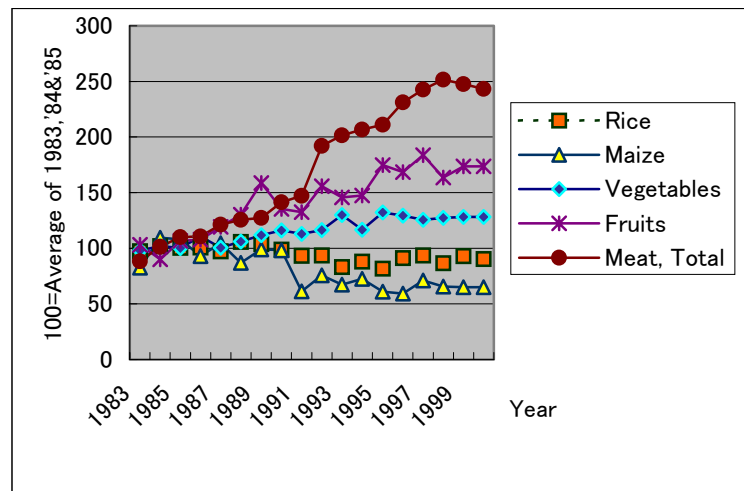
#### (2.4.1.2) Development of agriculture

##### a) Improvements in agricultural production structure

<sup>5</sup> The data source of this chapter is "FAO Statistical Data Base," except for those on fish catch, fishery population, and fisherman's income, which were provided by NFRI.

The agricultural production structure of the Republic of Korea underwent substantial changes in the 1980's and 1990's. Figure 2 shows time series values of production indices of major crops, of which 100 means the average production over a three-year period from 1983 to 1985. While production of grains such as rice, maize and barley remained unchanged or decreased, increased was production in such products as meats, fruits, or vegetables for which the demands increased as a result of increases in income. Over the recorded period, the area of farmland that was cropped to vegetables remained unchanged at the level of 400,000 Ha; on the other hand, the area of fruits increased by 60 % to 180,000 Ha. In view of these facts, the agriculture sector of the Republic of Korea could be deemed to have undergone the transformation of its production structure more or less in line with the changes in the demands as being indicated in the basic directions of the Fifth Five Year Plan.

**Figure 2: Production Indices**



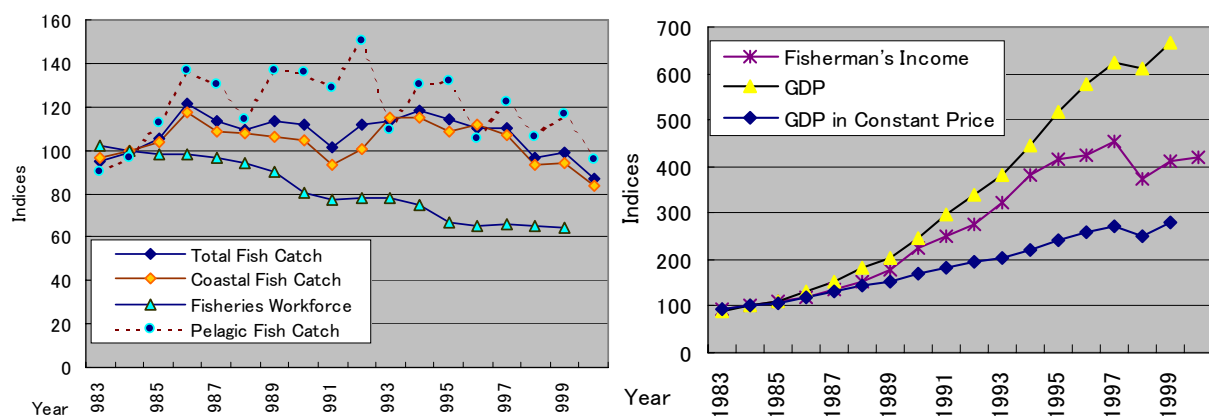
Source: FAO Statistical Database

#### (2.4.2) Impact on the fisheries production

##### (2.4.2.1) Improvements in productivity

Figure 3 shows fisheries statistical indices (the average of 1983, 1984 and 1985 equals to 100) from 1983 to present of the Republic of Korea. Both the indices of total fish catch and coastal fish catch, largely speaking, remain unchanged and show from around 1993 or 1994 gradual declining trends. Decreasing trends in the traditional coastal fish catch are reflective of the diminishing fisheries resources and the pollution in the coastal fisheries zones.

**Figure 3: Fisheries Statistics**



Source: FAO Statistical Database, IMF IFS Yearbook, NFRI

Note: Total Fish Catch = Coastal Fish Catch + Pelagic Fish Catch

The aquaculture was one of the major research areas that were financed with the ODA Loan. The production increased in this sub-sector from 540,000 ton in 1980 to 780,000 ton in 1985, and thereafter, it

increased further to 996,000 ton in 1995. The recorded aquaculture production in 1997 was 1.02 million ton and that accounted for about 40% of the total coastal fish catch, i.e., 2.4 million ton of that year. In the pelagic fisheries sub-sector, which was another priority area of the Project, the fish catch reached high levels in the late 1980' and early 1990's when they were compared with the total fish catch and the coastal fish catch. The fish catch in the pelagic fisheries sub-sector began declining in the latter half of 1990's but it still kept such levels as those in early 1980's. In sum, the fisheries sector, as well, accomplished transformation "from fisheries by catching to fisheries by breeding" which was identical to the basic direction of the "Vitalization Plan for NFRI."

As for the workforce in the fisheries, it decreased by almost 40 % over the 16- year period from 1983, and in 1999 the number was down to 170,000. Since the total fish catch remains unchanged over the period, the physical productivity of labor is evaluated to have attained substantial improvements in the fisheries sector as well.

#### (2.4.2.2) Development of fisheries

Fisherman's nominal income shows a constant upward trend up to 1994, lagging behind the nominal GDP growth though, but thereafter, it starts to stagnate.

#### (2.4.2.3) Impact on environment

There are no observable particular impacts on the environment caused by the experiment, research and technological development activities themselves.

## **2.5 Sustainability**

### (2.5.1) State of the tools, machines and equipment procured with the Yen Loan

RPA procured 1,788 items. Most of the procured items have exhausted their years of normal life span. Accordingly, they have been disposed of and are orderly being replaced with new ones or alternatives.

.. The Agricultural Science and Technology Institute keeps 57 items, the Plant Experiment Station keeps 60 items and 4 other experiment and research institutes keep the rest of the 228 items. Out of those 228, 125 items comprising mainly those that are relatively resistant to disorder, such as microscopes, crashers, or dryers, are in the state of active use or ready for use.

At the time of project formulation, RPA had a micro-mechanics room within the headquarters, and the room had a specialized function of repairing and maintaining the tool, machines and equipment for experiment and research. RPA was capable at that time of carrying out repairs and maintenance of the tools, machines and equipment internally. However, successive deployment of the state-of-the-art machines and equipment made the repair and maintenance coverage of the micro-mechanics room lesser and lesser because those highly sophisticated items had to be maintained and repaired by the manufacturers themselves. Consequently, the room was dissolved in May 1995. Ever since, each experiment and research institute was to designate officers in charge of the maintenance of each item and let them take care of the tools, machines and equipment. Repairs were carried out by the contract on the account of each institute. RPA was of the view that each of the experiment and research institute under its supervision was not short of budget for repairs. RPA has stopped to have the ODA Loan procured items repaired by the outside experts, simply because all those items are so old that the same types or models are not being manufactured any more.

NFRI procured 669 items, out of which 125, or about 19%, are in still active use. Most of the remaining 544 were disposed of because of expiration of economic life span and some others as well because of disorder. There are no items for the moment that are left idle or neglected due to no needs or disorder. An example of actively used item was the aquaculture experiment equipment called aquatron that

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<sup>6</sup> RPA does not keep separate books to keep track of the items procured with the Yen Loan. Accordingly, RPA has to estimate the sources of fund with which particular items were procured.

was procured in 1988. At the time of the field survey, soles breeding experiments were orderly going on using aquatron. On the other hand, the satellite remote sensing equipment had been replaced with new models and was displayed in the fisheries science museum built in the same compound of NFRI head office.

In the fisheries sector, the general administration section in the NFRI head office has been, from the time of project formulation, in charge of keeping track of the tool, machines and equipment, and all the repairs that should be contracted out have been processed through this section. As a result, the general administration section keeps good records of the state of the items, and there appear to be no problems with respect to maintenance including the state of item utilization and repairs.



### Comparison of Original Plan and Actual

Item	Plan	Actual
① Scope 1. Agriculture Research (1) Experiment and Research institute to be financed (2) Research themes and tools, machines and equipment	33 institutes  Soils and fertilizers Plant physiology Pest and diseases Agricultural produce storage technology Biotechnology Farm mechanization Wheat and barley Agro chemicals Paddy Field crops Sericulture Horticulture Research support 387 kinds (about 2000 items)	35 institutes  Livestock and veterinary science were added  Same as left          293 kinds (1788 items)
2. Fisheries Research (1) Experiment and Research institute to be financed (2) Research themes and tools, machines and equipment	16 institutes  Marine environmental survey Fisheries resources survey Fisheries technology development Breeding technology Fisheries freight and processing Inland fisheries 158 kinds (about 400 items)	Same as left  Same as left      170 kinds (669 items)
② Implementation Schedule 1 Agriculture Research 2. Fisheries Research	July 1984 – December 1986 July 1984 – December 1986	July 1984 – August 1989 July 1984 – August 1989
③ Project Cost 1 Agriculture Research Foreign currency Local currency (Local currency in Won) Total Out of which, ODA loan Exchange Rate  2. Fisheries Research Foreign currency Local currency (Local currency in Won) Total Out of which, ODA loan	2,600 million Yen 520 million Yen (1,695 million Won) 3,120 million Yen 2,600 million Yen 1.00 won = 0.307 Yen (July 1984)  700 million Yen 140 million Yen (456 million Won) 840 million Yen 700 million Yen	2,600 million Yen 346 million Yen (1,695 million Won) 2,946 million Yen 2,600 million Yen 1.00 won = 0.204 Yen (1984-'89 average)  692 million Yen 82 million Yen (400 million Won) 774 million Yen 692 million Yen

Exchange Rate	1.00 won = 0.307 Yen (July 1984)	1.00 won = 0.204 Yen (1984-'89 average)
3. Total		
Foreign currency	3,300 million Yen	3,292 million Yen
Local currency	660 million Yen	438 million Yen
(Local currency in Won)	(2,151 million Won)	(2,095 million Won)
Total	3,960 million Yen	3,720 million Yen
Out of which, ODA loan	3,300 million Yen	3,292 million Yen
Exchange Rate	1.00 won = 0.307 Yen (July 1984)	1.00 won = 0.204 Yen (1984-'89 average)