AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

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Batch #31

1. SUBJECT CLASSIFICATION	A. PRIMARY: Agriculture	AE10-0000-G704
	B. SECONDARY: Agricultural economics--Korea Rep.	

2. TITLE AND SUBTITLE
Investment priorities in the Korean agricultural sector

3. AUTHOR(S)
(101) Korean Agr. Sector Study Team

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1972	341p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Mich.State

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)

9. ABSTRACT

10. CONTROL NUMBER: PN-AAB-767	11. PRICE OF DOCUMENT
12. DESCRIPTORS: Investments, Korea Rep., Requirements	13. PROJECT NUMBER
	14. CONTRACT NUMBER: CSD-2975 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

INVESTMENT PRIORITIES

IN THE

KOREAN AGRICULTURAL SECTOR

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1972

Preface

This study is one of the outputs satisfying a contract (AID/EAD-184-Korea) between USAID and Michigan State University.

As required by this contract, a review of an early draft of the Korean agricultural sector study, Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, in April and May, 1972, revealed several broad areas for potential development investment in the Korean Agricultural Sector which could be provided by the Korean government and/or foreign and international agencies such as USAID and IBRD.

This review assigned priority rankings and summarized the KASS findings which led to identification of each investment possibility. With the time and resource constraints and the priorities identified in the KASS study in mind, the ROK government, AID, and MSU agreed in late May upon three broad areas of concentration for study -- agricultural research, agricultural input and product marketing, and land and water resource development.

This study was charged by the contract to "Identify those elements or subsections which require further investment to optimize the development of the agricultural sector, giving the priority sequence and time frame in which these investments should be made, the magnitude of this investment schedule, the most feasible sources of investment funds and the rationale for selecting investment areas, given selected price, program, and policy alternatives." It was further charged to "outline policy program, institutional and other pertinent requisites for the successful employment of the additional capital investment indicated."

The KASS team of investigators was comprised of Koreans and Americans, most of whom had participated in the earlier KASS efforts. The study was accomplished during a three month period between June 1 and August 31, 1972, with the team composed in task forces focused on each of the three major areas of investigation.

The land and water resource development task force was composed of William J. Haley, MSU; and Young Sik Kim, AERI. They were ably assisted by Margo Rich, a senior agricultural economics student from Cornell University who joined the team during her summer vacation stay in Korea.

The agricultural input and product marketing task force included John N. Ferris, MSU; Lawrence W. Libby, MSU; Han Hyeck Suh, AERI; In Joon Seol, AERI; and George E. Rossmiller, MSU and KASS Field Project Leader. Their analysis benefited particularly from interaction with Thomas J. Manetsch, MSU and Sang Gee Kim, AERI, KASS team members.

The agricultural research task force was comprised of Sylvan H. Wittwer, Agricultural Experiment Station Director, MSU; and Glenn L. Johnson, MSU and KASS Project Director. They were greatly assisted by the helpful suggestions and groundwork laid by James Cobble, Everett Christopher, and George Estes, USAID contractors at Suwon, and by interaction with Dr. Hyun Koo Pyo, Dean, College of Agriculture, Seoul National University; Dr. In Hwan Kim, Director, Office of Rural Development; and personnel from Rockefeller Foundation.

General data collection and computational support was provided by Soon Koo Shim, AERI. James Williams, MSU; and Boo Kwan Lee, AERI provided computer programming support. Kyeong Soo Kim, MSU; Doris Gulilan, USAID/RDD; and Jeong Suk Cho, MAF, provided computational and secretarial services. Secretarial and administrative services were provided by Kay Cooper, MSU, who also typed her way through numerous drafts and the final manuscript.

Numerous individuals from public and private agencies in Korea contributed generously of their time and energies in providing data, information, and analysis for use by the study team. Francis Jones, Chief; and Robert Morrow and Marc Winter, staff, Rural Development Division, USAID/Korea provided valuable support and helpful criticism and suggestions throughout the study.

The study was jointly financed by the Government of the Republic of Korea through the Ministry of Agriculture and Forestry and the United States Agency for International Development through the Rural Development Division, USAID/Korea.

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Major Conclusions and Recommendations and Priorities

The following conclusions and recommendations are summarized from the study and are listed in order of investment priority.

1. Agricultural Research. A substantially increased agricultural research program for varietial research in rice, barley, wheat, soybeans, and forages, initially staffed primarily with foreign scientists and administrators is recommended for immediate implementation. The increased program should add yearly operating expenditure of about 2 million dollars to present expenditures for a period of at least 10 years. Benefits are expected to reach a yearly rate of over 30 times yearly costs by 1975, and over 160 times yearly costs by 1980. (Chapter 12)

2. Transportation. As commercialization in the agricultural sector continues, the demands on the transportation system for delivery of inputs to the farm and of commodities to market increase substantially. The demand on the transport system associated with agriculture is estimated at 32 million MT-km. between field and village, 10 million MT-km. between village and truck road, and 120 million MT-km. on truck roads to ultimate consumer in 1971. By 1981 these figures are expected to increase to 39 million MT-km., 17 million MT-km., and 269 million MT-km., respectively. Benefit-cost ratios for field to village roads are calculated at as high as 7.5:1 at 10 percent interest and 5.0:1 at 25 percent interest for the saving in transport cost alone. For village to truck road or market, B/C ratios as high as 15.1:1 and 9.5:1 are calculated for 10 and 25 percent interest rates, respectively. Benefits from more optimal application of inputs such as lime, fertilizer, and chemicals, and enhanced ability to mechanize are not included in these B/C ratios but would be substantial. Further investment in the rural transportation system is crucial to the continued development and commercialization of the agricultural sector. The construction of approximately 18,000 km. of village to truck route feeder roads at a cost of 9 to 16 billion won, depending on land costs, is recommended. Construction in 1971 and 1972 is not taken into account in the 18,000 km. recommendation. Continued addition to and improvement of

the village to field transportation network is recommended as is continued improvement of particularly the unpaved truck roads linking into the national road system. (Chapter 11)

3. Irrigation. Thirty-four centrally funded irrigation projects in various stages of completion were analyzed with respect to the economic feasibility of completion. All have favorable B/C ratios and particularly if foreign loan sources consider the additional cost for completion to be the total cost, most would be excellent objects of foreign investment. Completion costs of all 34 projects involving a total of about 29,000 hectares is estimated at 9.9 billion won.

A preproject feasibility investment study rule was devised for allocation of feasibility studies between reservoir and pumping projects to increase the average B/C ratio of government sponsored projects. The average B/C ratio of the 34 projects analyzed in devising the rule was 2.56:1 with a range from 1.57:1 to 5.53:1. The rule indicates that in order to maximize the average benefit-cost ratio for a group of irrigation projects, present allocations should be sixty percent to pumping and 40 percent to reservoir type projects. (Chapter 3)

4. Drainage. Total paddy in need of subsurface drainage is estimated to be between 159,000 and 194,000 hectares. With improved yields and additional double cropping made possible, an additional 17 billion won can be added to Korean social product with 13 billion won of additional farm income on a value added basis. Benefit-cost ratios for subsurface drainage at an 18 percent interest rate are 6:1 for double cropping areas and 4:1 for single cropping areas. Immediate establishment of several pilot drainage projects across Korea is recommended to collect further engineering and economic data to support the argument for extensive investment in drainage projects. (Chapter 4)

5. Agricultural Credit and Government Grain Management Policy. With projected population shifts, rapid commercialization is expected in the agricultural sector as well as a substantially increasing trend toward purchased farm inputs, particularly as capital replaces labor. Short and intermediate term production credit needs are projected to increase from 74 billion won in 1971 to about 134 billion

won in 1981. A number of institutional changes and changes in grain management policy are recommended to streamline the credit system to meet future needs. In addition, foreign loan financing could be used for specific programs requiring farm level credit such as a farm mechanization program. (Chapter 8)

6. Market Information. As the agricultural marketing system expands and becomes more complex, the demand for more and better market information by all participants increases. Key elements in an effective market information system include a timely, objective, and effective market information and data collection network, a generally accepted system of standards and grades, and a rapid and dependable communication network. Opportunity for investment from national or international sources exists in at least three areas -- improvement and expansion of the communication media, operation of an agricultural market data reporting system, and training in collection and use of market data and information. Initial costs for the agricultural market information system example shown in the text would total 39 billion won (38 billion won for a rural telephone network) and annual costs would amount to 349 million won. (Chapter 9)

7. Storage Requirements for Grain and Pulses. With completion of the new storage capacity presently planned by NACF, nonfarm storage facilities and capacity will be adequate until about 1976. The increased on-farm storage capacity required amounts to about 350,000 MT. Between 1976 and 1981 an addition of about 118,000 MT nonfarm storage capacity will be needed provided more judicious use of existing storage is made and substantially increased capacity is developed for on-farm storage.

The additional off-farm capacity would cost approximately 472 million won at 10 percent interest or 1 billion won at 25 percent interest. Benefit-cost ratios calculated for cement type on-farm storage with a reduction of storage loss from 13 percent to 5 percent were 31.5:1 at 10 percent interest and 11.0:1 at 25 percent interest for rice, and 30:1 and 10:1, respectively for barley. Benefit-cost ratios calculated for savings through construction of on-farm rather than off-farm storage and for savings in transport costs were 2.0:1 and 1.24:1 at 10 and 25 percent interest, respectively. Construction cost for cement type farm storage is estimated at roughly 7,500 won per MT. For 350,000 MT, farm storage capacity total construction cost would be approximately 2.6 billion won. (Chapter 10)

8. Upland Development. Approximately 200,000 hectares of land with slopes ranging up to 24 degrees presently classified as forest land are identified as potentially developable for agriculture. Of this 200,000 hectares, 41,000 hectares could be used for cultivation of all upland crops, 44,000 hectares for orchards, 74,000 hectares for pasture and mulberries, and 41,000 hectares for improved native grasses and possibly mulberries. Regression and linear programming analyses indicate that the pressure for additional agricultural land development will remain strong, but from a purely economic point of view, agricultural output increases should be achieved for the most part by increasing productivity on existing agricultural land rather than concentrating on new land development.

Selected upland development projects may be identified particularly if nonmonetary benefits are imputed and if they satisfy public works objectives in situations where unemployment exists. In general, however, upland development as an investment potential must be placed at a low priority. (Chapter 5)

Conclusions are drawn and recommendations made throughout the text with respect to alternative means of achieving objectives, institutional arrangements, policy guidelines, and investment sources specific to the potential investment component being analyzed.

P a r t I

GENERAL PERSPECTIVE AND ISSUES

George E. Rossmiller

Chapter 1

General Perspective and Issues

Korean agricultural sector development to date has been a process toward which contributions have been made by many and varied participants. The major of these participants have included the persons comprising the some 2.5 million farm households engaged in production agriculture ; the public agencies and private firms responsible for supplying agricultural inputs, marketing agricultural products, and improving the rural infrastructure within which agriculture functions; the governments at all levels from the village to the central government in Seoul responsible for the planning, policy formulation, program execution, and carrying out projects designed to accomplish the goals of agricultural sector development in line with their interpretations of national values; and the foreign interests and international agencies providing grants, loans, technical assistance, and other inputs to the process, in line with their own interests and hopefully in line with the needs of Korea and her agricultural sector. These participants with widely varying motives and intentions operate sometimes in concert, often independently, and occasionally at odds in making their contributions to agriculture sector development.

In a venture as complex as the continued development of a country's agricultural sector it is extremely important that public investment decisions be planned and coordinated with past and ongoing policy and program development. This study focuses on general economic analyses of potential investment in specific aspects of the agricultural research system, the agricultural input and product marketing system, and the land and water resource development complex. The analyses are at the pre-project feasibility level, in that specific projects are not identified, and detailed technical and engineering data analysis, normally associated with project feasibility studies, has not been done. The results indicate, however, those areas which hold promise of high economic returns and provide indications of where project feasibility studies are warranted.

It is important at the outset that we, the investigators, and you, the reader, understand as completely as possible the nature of the constraints imposed and flexibilities allowed by (1) the nature and extent of the future demands on the agricultural sector and, thus, on the agricultural research, marketing, and land and water resource systems, and the extent of prior investment in those systems, (2) the institutional and policy constructs currently operating within each system, and (3) the economic, social, and political environment within which each system operates. These issues raise some basic value oriented questions which must be answered or toward which assumptions must be addressed. The questions and assumptions much be confronted before we continue.

Future Demands -- Prior Investment

The contributions of the agricultural sector to the development of the total economy include: (1) food, (2) employees for urban commerce and industry, (3) land for nonagricultural uses, (4) raw materials for industry, (5) export earnings and foreign exchange savings, and (6) government revenues, savings and newly formed capital contributing to the development of both the farm and nonfarm economies. The nature of these contributions are discussed in detail in the KASS report. Their magnitudes are briefly indicated here with emphasis upon (6).

KASS projections indicate that by 1985 domestic production of food will probably increase by about 50 percent on about the same cultivated land area, but with about 1.5 million fewer farm laborers. Purchased and farm produced capital inputs will substitute for both land and labor in the form of yield and labor productivity increasing technology (machinery, fertilizer, chemicals, improved varieties and breeds, new cultural and animal practices, and so forth). No attempt was made by KASS to determine the investment required in plants, equipment and material to produce and deliver the nonfarm produced capital to the agricultural sector. Evidence in the form of projected requirements for these capital inputs indicate it to be significant.

KASS further projects a migration of about 10 million persons from the rural to the urban sector by 1985. Most of these migrants will be young and hopefully well trained and educated in their local rural educational systems in order that they can support themselves and their families and contribute to Korean growth and development through their labors in the urban sector. Additionally, the growth of the nonfarm economy will contribute to the nonagricultural demands for land. Approximately 40,000 hectares of land will be needed each year for urban housing, industrial and commercial sites, reservoirs, streets and roads, and urban service areas. About half of this land area will be converted from agricultural land; the rest, from forest. Thus, in order to maintain the agricultural land base, new land must be developed at an annual rate of about 20,000 hectares.

The emphasis of Korean agriculture has been on food rather than industrial crop production. Notable exceptions have been silk, some tobacco, limited leather, rush, and straw. More recently rape, seasame, and perilla have expanded at the expense of cotton and hemp. Between now and 1985, Korean agriculture can provide raw materials for a major expansion in marketing and processing by the nonfarm economy, due to both increased production and greater commercialization. The food marketing industry may expand as much as 2½ to 3 times, while the processing industry, including industrial crop processing, will expand even more. Again, KASS did not attempt to project the total agribusiness capital requirements necessary to market and process this increased volume, but the magnitude is substantial.

Agricultural exports have increased seven fold since 1961 to 100.5 million dollars in 1970, while the agricultural share of total exports dropped from 30.8 percent to 12.0 percent during the same period. In 1970, agricultural imports exceeded agricultural exports by the difference between 239.8 million dollars and 100.5 million dollars. If the consumption mix can be changed and production increased toward closure of this gap, a substantial saving can be made in foreign exchange.

Korean agriculture is a greater source of capital for development of the farm and nonfarm economies than is commonly realized in lender and grantor circles, and possibly

The same holds true to a somewhat lesser extent for the agribusiness complex surrounding production agriculture. As the marketing and input supply services expand, adapt, and modernize, a limited amount of new capital can be generated by underemployed traditional labor and capital. Even more important, however, are the complementary public investments in such infrastructural improvements as communication facilities and transportation networks. Equally important are the product marketing and input supply facilities themselves which can only be provided out of new capital, whether public or private.

Table 1-1 indicates the KASS projected increases in flow volume of selected products and inputs through the agribusiness channels between 1971 and 1985. As can be seen, a substantial change in the mix of products marketed and inputs supplied, as well as increases in levels is implied.

Thus, in order to modernize and further develop production agriculture, the agribusiness complex supporting it, and the rural infrastructure surrounding both, large coordinated and timely capital investments must be made from many different private, public, and international sources. Sound planning, policies, and institutions are required if this development is to take place efficiently at the proper rate in a coordinated manner with capable and willing participants.

Policies and Institutions

Policies and the instruments by which they are executed create a host of consequences -- some desirable, sometimes undesirable; some planned, sometimes unplanned; some consistent with prior policy and planning, sometimes not; some consistent with prior investment and sometimes not. The investment study team working on this project must take certain national values, guidelines, and policy directions as given; but they must be quite clear as to the nature of the givens.

Only the top decision makers in Korea can determine some of these givens. One of the basic questions is the appropriate balance between direct governmental intervention, coercion and exhortation to accomplish the developmental

Table 1-1: Ratios of Increased Flows of Products and Inputs in the Product and Input Marketing Systems 1971 - 1985 1/

Item	1985/1971
Grains and Pulses	1.91
Fruit	2.84
Vegetables	2.03
Potatoes	2.98
Beef	3.70
Milk	9.71
Pork	2.03
Chicken	4.23
Eggs	4.38
Fertilizer	2.6
Chemicals	1.7
Capital Requirements	3.9
Concentrate Requirements	2.0
Tillers Sales	6.2
Equipment Repair, Maintenance, POL	29.2

Source: Rossmiller, et. al., Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, AERI-MAF, Seoul, Korea and Department of Agricultural Economics, Michigan State University, East Lansing, 1972

1/ Marketed commodities increase faster than production due to commercialization (urbanization).

objectives in the agricultural sector and governmental establishment of guidelines and "rules of the game" which create an environment in which participants are inclined to do the things the government wants them to do in achieving development objectives. Should the government supply the materials and plans for improvement in rural villages, or give subsidies on certain materials and provide planning help on request, or make block grants to villages for use as the village people see fit, or direct policies toward increasing rural incomes, thereby generating increased tax revenues for village improvements, or should some other means be devised? In each case the policy objective, or at least part of it, is to improve rural villages. But in each case, the extent and nature of direct government intervention differs. So also do the participants making the allocative decisions. This in turn may, and probably will, lead to different decisions regarding what is to be done, priority, and timing. Thus, decisions on new investment and its corrolation with prior investment will be quite different in each case. It is however, extremely important, whoever the ultimate governmental investment decision makers are, that they take into account investment decisions which have already been made and which are most likely to be made by other participants -- farmers, agribusiness entrepreneurs, and other public agencies and private persons. These governmental investment decision makers must also realize that the investment decisions and policy directions determined by them will have an influence on the investment decision making by these other participants.

The governmental policies and policy instruments used for grain price stabilization is an illustrative example of the above point. It is apparent that the government is interested in stabilizing both the domestic producers price, and the consumers price of rice. This is presently being attempted through the grain management stabilization account with government purchase of rice from domestic producers, government management of rice imports, and government sale of rice to consumers. In order to insure a smooth and orderly flow of rice from producer to consumer during the marketing year, someone -- either the government or the farmer or some of the various participants in the marketing system itself -- must bear the burden of holding and storing rice between the time of harvest and the appropriate time for its release to consumers. A set of grain management policies can be devised whereby this total burden would be borne by the government. Another set could be devised which would shift this burden to the farmers. Alternative sets could be devised which would place the storage and sale burden upon different participants in the marketing system, or on some combination which would also include government and farmers. In each case the need for storage facilities, their geographic location, their type, and the participants investing in them would differ markedly. It is important that the policy decisions be made and carried out in a rather long time frame in order that investments once made in fixed facilities and equipment remain viable. It would be an unfortunate waste of scarce resources, material, and capital to build storage facilities under one set of policies and then to change the policy direction in such a way as to make it unprofitable to use those facilities by shifting the storage burden to other participants.

The role of institutions, particularly in the marketing system, is also extremely important. Market regulation and control policies, quality standards and grades, if well designed and administered, can be powerful tools in assuring an efficient, orderly marketing system delivering a quality product to the ultimate consumer. And in many cases, it can have desirable side consequences in fulfilling other objectives better and more painlessly than direct governmental intervention. For example, rigidly enforced quality standards with respect to the amount of foreign matter allowable in marketed grain may be a greater incentive for farmers and others in the marketing system to effectively control rats than the present governmental exortation programs.

Another set of institutions whose roles must be reassessed and more clearly defined are the semiautonomous governmental agencies such as ADC, AFDC, ORD, and NACF. How will NACF develop over the next ten - fifteen years in becoming one of the viable sources of credit and a marketing and input supply institution with a main objective of serving farmers? In the future will the government attempt to control the level of and access to agricultural credit? Or will government attempt to establish a climate in which agricultural can compete in the more general market for investment and credit funding?

During the sector study several different policy strategy sets were assumed and the consequences of following each of those strategies analyzed. The question being addressed was -- what if Korea followed these policies? In addressing that question, very few parameters needed to be taken as given. But the investment study is quite a different story. In this instance it is necessary to either know, or to use our best judgment in assuming, what policy directions will be taken, which policy instruments will be used in their execution, and the role the various institutions will play in the development of the agricultural sector in the years ahead. Wherever possible within the limited time frame and resources allowed to the investment study, policies and institutions are analyzed with respect to their effectiveness and,in some cases, recommendations are made for change. For it is not only possible, but highly probable, that policies and institutions designed to provide incentives and to make it profitable for individuals to do those things which contribute most to agricultural sector development can be as effective, if not more so, than large injections of governmental investment funding into projects and programs, while at the same time, policies and institutions deny the necessary incentives. It is with these qualifications and reservations that we proceed with this investment study.

Study Organization

The study is organized in four parts. Part I provides an introduction to the study and sets forth the general socio-economic and policy context within which the specific investment topics are analyzed. It is essential that the issues addressed in this part be kept in mind, to place the contents of the rest of the study in proper perspective.

Part II deals with three aspects of land and water resource development. With the increasing demands on the land base for additional food for an expanding population with growing incomes, as well as for urbanization and industrialization, it is important to look at Korea's potential for developing new agricultural land base and for increasing the productivity of the existing agricultural land base. Through initial study of existing documents including KASS findings, and discussion with ROK, AID, and UNDP officials, the priority concerns in this resource development area emerged as irrigation, drainage, and upland development.

Part III deals with agricultural input and product marketing. In view of anticipated population shifts, national growth rates, and farm commercialization, substantial investment is needed in the agricultural marketing system. The purpose of Part III is to identify the most promising investment alternatives in the movement of farm commodities from producer to consumer and required inputs back to the farm unit.

The general procedure used is to analyze the nature of demands on major components of the agricultural marketing system, identify key bottlenecks or priority needs within that system, suggest investment or institutional options for improving the system, estimate general benefits and costs of those options, and make recommendations on policy, institutional, and investment needs.

The marketing system is defined broadly to include both public and private components and the utilities of location, time, form, and possession which they provide for agricultural commodities and inputs. Commodities include primarily grain with limited analysis of fruit and vegetables. Inputs include fertilizer, chemicals, and machinery.

Within the time and resource constraints imposed on the study, priorities were required. After consultation with ROK and AID, components of the marketing system selected for study emphasis include (1) bottlenecks in farm to first receiver segment of marketing system, (2) agricultural credit requirements and related central government grain management policies, (3) market information system, (4) storage requirements for agricultural commodities and inputs, (5) transportation of commodities and inputs -- emphasis on farm to first receiver.

Clearly, these are not separate items, but interrelated components of the overall marketing system and, insofar as possible, are treated as such in the analysis.

Part IV deals with agricultural research. Due to the long time lags between initiation of effort and innovation of results and the high potential benefits identified by KASS to increased emphasis on agricultural research, this area was selected as top priority for further investigation in this study. Concentration is on biological and chemical research where the time lag and potential gains appear most pronounced. The analysis (1) inventories the present Korean agricultural research program, institutions, and results, (2) surveys research experiences elsewhere in the world which are of relevance to Korea, (3) presents a program design for expansion and further development of Korean agriculture research, (4) indicates investment needs and potential payoffs, and (5) provides a plan for program development and implementation including both domestic and off-shore budget components.

The level of analysis in this study varies considerably from component to component, depending upon availability and quality of data, nature of the component, and implicit priority within each set of components assigned by the investigating team. In all cases, however, the investigation is carried out at the preproject feasibility level and further in depth project analysis to determine specific engineering and economic feasibility will be required prior to actual investment.

Part II

LAND AND WATER RESOURCE DEVELOPMENT

William J. Haley
Young Sik Kim

Chapter 2

Introduction

Korea has been engaged in various forms of land and water development on both a privately and publicly financed basis for many years. Several rather sophisticated irrigation projects were completed in the early 1900's during the Japanese occupation and are still in operation. However, the bulk of land and water development during these early years was on a small scale and much of it was privately financed. Since 1946, both the number and size of projects for land and water development have increased quite rapidly. Table 2-1 indicates yearly expenditures on water development between 1946 and 1971. It is clear that government responsibility for water development has increased. The average government share of land and water development for the period 1946 through 1971 was approximately 44 percent, while the average for 1971 was a much higher 57 percent. Clearly, the role of the Korean government is an increasing one and there is no reason to suspect the relative share trend will be reversed. Since there is no "invisible hand" to guide investments made by government, it is important that careful study be given to at least a limited set of alternatives before funds are committed.

The purpose of this chapter is to look at such alternatives, but not in the usual sense of comparing one project to another. Rather we attempt to identify types of investments which appear to be better in an economic sense than others. In particular, we attempt to make comparisons among and within irrigation projects of various types, drainage systems of various types, and upland development. Should we discover investments which appear particularly amenable to foreign donor agency loans, some attention will be paid to institutional mechanisms to facilitate the resultant loan possibility.

Any time costs or benefits are mentioned in this chapter, the reader is cautioned to interpret them as <u>average</u> costs or <u>average</u> benefits unless otherwise noted. In making comparisons among types of irrigation projects,

Table 2-1

Expenditures on Water Development, 1946, 1971 1/

Unit: Thousand Won

Year	Government Funds 2/	PL480	Farmers' Funds	Total
1946	86		11	97
1947	344			344
1948	635			635
1949	2,277		5	2,282
1950	1,402			1,402
1951	9,148			9,148
1952	55,620			55,620
1953	120,064			120,064
1954	566,139			566,139
1955	1,898,259		11,964	1,910,223
1956				
1957	2,012,877			2,012,877
1958	1,789,186			1,789,186
1959	1,697,751			1,697,751
1960	1,146,936			1,146,936
1961	2,161,384			2,161,384
1962	1,024,630		44,990	1,069,620
1963	971,474		67,632	1,039,106
1964	1,054,101		71,494	1,125,595
1965	1,566,100		104,299	1,670,399
1966	3,257,158		259,937	3,517,095
1967	3,052,128		281,711	3,333,839
1968	3,210,638	109,020		3,319,658
1969	4,790,786	6,772,214	1,811,291	18,374,291
1970	11,265,842	85,158	2,630,218	13,981,218
1971	8,491,039		482,275	8,973,314

1/ In current won.

2/ This includes both federal and provincial funds and includes low interest loans to farmers.

Source: "Plan for Establishment of Agricultural Production Base," 1972 Farm Land Improvement Division, M.A.F. (In Korean).

it is necessary to consider average costs and benefits because individual project costs and benefits will vary due to a host of geographical, physical, technical, and managerial differences. Where these differences seem unusually large, as measured by some function of the sum of squares of deviations from the mean, the reader will be properly warned.

In interpreting the results of the following comparisons the reader is cautioned to avoid the implication that, for example, all reservoir type irrigation projects are better (or worse) in an economic sense than, say, all water pumping type irrigation projects. When using averages, such implications are incorrect and misleading. The correct implication is that on average one type of project is preferred to another. When comparing two or more specific projects, a feasibility study should be carried out to determine which is preferred on economic grounds. By comparing projects by type, we hope to highlight investments which probabilistically will yield the highest rate of return at the margin. If the government has a portfolio of potential land and water development projects waiting to be funded, then it needs information on which type of investment has the highest average rate of return so that the portfolio can be most advantageously managed within the given budget constraint.

Korea's basic problem in agriculture is that it is a food deficit country and is very interested in closing this deficit gap. There are only two principle ways of accomplishing the objective. They are to extend the agricultural land base and to increase the yield on land already in production. These two methods are commonly referred to as more extensive and more intensive farming. At present, Korea is having more success on the intensive margin, although efforts are continuing on the extensive margin. Demand for both types of development arise out of the food gap and continued decline of the agricultural land base as a result of urbanization and industrialization. By 1981 1/ an estimated 178 thousand hectares of agricultural

1/ R. Barlowe, "Land and Water Development Policy Issues in Korea," Korean Agricultural Sector Study Working Paper, Michigan State University, East Lansing, 1972.

land will be lost to other uses such as those mentioned above. As a result, unless production increases (through either more extensive or intensive farming or both) are sufficient to offset production losses from urbanization and population increases, the food deficit will increase--an event Korean policy makers would prefer to avoid. Their objective, of course, is not only to stop it from increasing, but to attempt to close the gap.

The principle methods employed by the Korean government to accomplish the goal referred to above fall into the following general catagories; upland development, paddy rearrangement, medium scale irrigation projects, and large scale multipurpose development projects. The sources of funds for implementing these methods are the central government, the provincial governments, the farmers benefiting from the project, and foreign donor agencies.

Upland development is a means of extending the land base in Korea. In 1972, 600 hectares have been developed at a cost of 112 million won. The task involves land clearing, erosion control, and terracing as well as building roads. Some 80 percent of this activity is subsidized by government funds with the farmers paying the other 20 percent. 1/ In the Third Five Year Plan a total of 13,000 hectares of new upland will be developed. Much of the land is marginal and, as a result, is never used in production. For example, while in 1972 some 600 hectares were developed, only 325 hectares, or 55 percent, came into production. With farm population declining and urbanization continuing at a rapid rate, it doesn't appear that the total area of developed upland used in production will increase. 2/

A second method currently being employed by the government in increasing production is the paddy rearrangement program. This method is used to make land already in production more productive by making paddies generally

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1/ Ministry of Agriculture and Forestry, Plans for Land and Water Development, Seoul, 1972.

2/ Barlowe, R.; Haley, W.; Kim, B.D.; Ryu, B.S.; and Vincent, W. "An Analysis of New Land Development in Korea," Korean Agricultural Sector Study Special Report 5, Michigan State University, East Lansing, 1972 more efficient to cultivate and more amenable to mechanization. In 1972, 26,000 hectares of paddy will be rearranged at a cost of slightly more than 6 billion won. This comes to about 235,000 won per hectare for rearrangement compared to slightly less than 200,000 won per hectare for upland development. Although the cost of rearrangement is slightly higher than upland development, the benefit of increased production appears to be greater for rearrangement. In many cases machinery which is needed for rearrangement, but which cannot be employed during the rice growing season, is employed in upland development during this time. By doing this, most of the capital cost represented by machinery is charged to rearrangement, making upland development appear more feasible from an economic point of view. When capital sharing is not done, this capital cost burdens the benefit-cost ratio of upland development quite adversely.

In addition to the benefits arising out of the operational efficiency of rice production after rearrangement, a second important source of benefits is the installation of proper drainage facilities on the rearranged paddy. Drainage is a serious problem in Korea, and in some instances, the soil is so impermeable that a subsurface drainage system under the paddy field is required, in addition to drainage ditches around the paddy fields.

A third method of increasing production currently being employed by the government is the medium size irrigation project. Projects of this sort usually have two purposes: irrigation and flood control. Irrigation is accomplished in one of two ways -- either the water is retained above the recipient paddy fields in a reservoir, or the water is pumped into irrigation canals from a source which lies below the paddy fields. Reservoirs tend to cost more to develop than pumping plants, but the operating cost of a reservoir is quite in relation to the pumping plant.

A fourth way of increasing production at both the intensive and extensive margin is the large scale, multipurpose development project. There are several projects of this type being planned and in progress, and a great deal of attention is being directed toward the multipurpose, large scale project. This type of development actively involves extending the land base as well as increasing production through improving existing land and water resources. During the Third Five Year Plan (TFYP) period, some 12 billion won is scheduled for large scale development and some 41 billion won for the big four river basin projects.

The number of ways benefits arise out of this type of development is larger than with the smaller projects. In many cases, while both types of projects claim similar kinds of benefits (flood control, for example), the large scale development project does a much more effective job due to size, and as a result, the benefits per unit of land are larger. There are many other examples of these economies of scale which is, no doubt, the reason Korea is going ahead with these large scale projects wherever possible. However, given the size of Korea, it is likely the opportunities for large scale development projects on the order of size of the big four river basin projects or the Pyeong Taek water development project are limited. This does not mean that comprehensive development of smaller areas is not economically feasible. It would appear that watershead development of the type presently being demonstrated by UNDP in several areas of Korea will be quite successful from an economic point of view. Important data will be coming out of these projects in the next year.

The method of financing land and water development has been a combination of provincial and central Korean government monies, individual farmer monies, and foreign monies. The various Korean government funds come in the form of direct subsidies to the area in which the project is located, or in the form of low interest loans to the Farm Land Improvement Association (FLIA) in the project area. We classify the loans as subsidies because the interest rate at which the loans are transacted is around 3.5 percent, which with current rates of inflation becomes a substantial negative interest rate. The farmer contribution comes from fees levied on the product of the project. These fees go toward covering current operating costs and debt retirement. The third source of funds comes in the form of loans, or grants to the Korean government from international agencies such as USAID, UNDP, or IBRD. At present, Korea has a substantial debt burden from past foreign loans, and whether more foreign debt would be desirable as opposed to internally financing new land and water development is not as clear cut as in the past. As a result, external financing should not be viewed as the obvious choice.

Ideally, an analysis of this sort should compare all the above types of investment, but time and manpower constraints force choices to be made. In what follows, various forms of irrigation, upland development, and drainage problems will be looked at intensively. Since large scale development projects are, in many respects, like several small scale projects put together, much of what will follow is partially applicable to them. In addition, time does not permit analysis of such a complex mode of development.

Careful and fairly intensive analyses will be carried out on medium size irrigation projects, subsurface drainage, and upland development, respectively. With regard to medium size irrigation projects, we will compare the economic returns of pumping type projects with reservoir type projects. The extent of the drainage problem in Korea will be estimated and benefit-cost ratios for subsurface drainage will be constructed and compared across methods. Then the potential of upland development will be considered after an optimal crop distribution on the new upland is determined. This potential will be discussed in light of two different price assumptions.

Chapter 3

Irrigation

In Korea, during the last several decades a large and continuous investment has been made in the development of water resources for irrigation. But Korean agricultural production has still suffered severe drought and flood damage. One MAF publication 1/ indicated that annual national damage from drought and flood in an average year comes to a total of 14.5 billion won. This yearly damage is 50 percent of total planned investment for irrigation projects during the Third Five Year Plan from 1972 to 1976. The fact that Korea has suffered from both drought and flood damage means that Korea has relatively abundant water resources, but an unfortunate seasonal distribution of rainfall coupled with a mountainous topography. One seminar report 2/ shows that at present, only about 13 percent of the total annual precipitation, or approximately 9.2 million cubic meters of water, is being utilized for agricultural, industrial, and home purposes. From this fact, it seems to be clear that there still remains a considerable potential for improved water supply management in Korea.

According to an Agricultural Development Corporation (ADC) Statistic Yearbook 3/, the ratio of irrigated paddy to total paddy area was approximately 80 percent at the end of 1970, a very rapid increase from less than 60 percent in 1967. However, this figure is questioned by many people. One reason is that a large portion of

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1/ Ministry of Agriculture and Forestry, Farm Land Improvement Division, "Plan for Establishment of Agricultural Production Base,", Seoul, 1972 (In Korean).

2/ Agricultural Development Corporation, "National Seminar on Water Management at the Farm Level," Seoul, 1972.

3/ Agricultural Development Corporation, Statistic Yearbook of Irrigation and Reclamation Work, Seoul, 1971.

underground water projects, such as tube wells and infiltration galleries which were intensively developed in the last several years, are not operational now. Subtracting the paddy area in this category, which is classified as irrigated paddy, from the irrigated paddy area, we can estimate the irrigated paddy will be slightly less than 65 percent of total. Another possible classification is to count only that paddy which is water fed by either a reservoir or pumping plant, a somewhat more stringent definition. By this classification, only 564,600 hectares or 44 percent of the paddy is irrigated; just over half of the official figure.

Another data source 1/ of MAF which has surveyed actual water supplies indicates that irrigated paddy is about 72 percent of the total paddy in 1970. It seems clear that, by almost any definition of irrigated paddy, the official figure is an overstatement. Clearly, the definition of "irrigated" paddy will influence the total amount of paddy which is presumedto be irrigated, and this definition needs to be clarified. Our point here is not to suggest a definition; this is a technical matter which others are more qualified to determine. We would suggest, however, that a definition be agreed upon and government statistics appropriately adjusted to reflect the new, more uniform definition.

Government Plan for Irrigation

The Korean government plans to bring a total of 121 thousand hectares of paddy, 44 thousand of which are in the big four river basin projects, into the irrigated paddy group during the Third Five Year Plan (TFYP). Assuming successful implementation of this TFYP, irrigated paddy will be approximately 90 percent of total by 1976,

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1/ Ministry of Agriculture and Forestry, Yearbook of Agriculture and Forestry Statistics, Seoul, 1971.

the maximum possible irrigated paddy according to MAF sources. A total of 30.3 billion won, approximately 7 percent of total investment in agriculture during the period, will be invested in new irrigation projects during the five years as shown in Table 3-1. Table 3-1 also shows how funds are divided between river basin paddy and non-river basin paddy.

At present, a total of 157 irrigation projects are under construction throughout the country with various starting years, construction methods, and sizes. Of 157, 34 projects are relatively large scale and will be implemented by the Agricultural Development Corporation (ADC), the others left to be implemented by Provincial Farm Land Improvement Association with technical supervision from ADC. Table 3-2 shows the irrigation projects under construction in 1972.

Of all these irrigation projects, we will intensively look only at the 34 ADC projects. We will enumerate each project listing certain critical data about each which may be of interest to potential loan agencies, and then attempt to determine if a viable rule can be established which will, at the prefeasibility stage, help policy makers in determining how they can most advantageously manage their portfolio of potential investments.

Central Government Financed Irrigation

There are two sources of water for irrigation, surface and underground. In 1968, 94 percent of the funds spent on irrigation projects was for developing underground sources. This method of water development has apparently not proven to yield satisfactory results as indicated by the fact that in 1971, 91 percent of irrigation project funds was spent in developing surface water resources. In the TFYP, 99 percent of the planned irrigation projects are surface water type projects, with only one percent being devoted to underground water development.

There are two types of surface water development in which the Korean government is heavily engaged. These are reservoir projects for holding water above the paddy

Table 3-1: Plan for Irrigation Projects as a Part of TFYP, 1972 - 1976

	Additional Irrigated Paddy Area ('72-'76)	Investment (1972-1976) Government Central	Provincial	Farmers' Share	Total
	Thous. ha.		(million	won)	
Outside Four River Basin	77	10,989	1,376	1,372	13,737
Inside Four River Basin	44	11,537	3,000	2,000	16,537
Total	121	22,526	4,376	3,372	30,274

Source: "Working Data for Third Five Year Plan," MAF, 1971.

Table 3-2: Irrigation Projects Under Construction 1972

	No. of Projects	Benefit Area	Average Size of Project
		(ha.)	(ha.)
ADC	34	28,849	848
Provincial	123	50,572	411
Total	157	79,421	506

Source: "Plans for Establishment of Agriculture Production Base," MAF, 1972.

for irrigating through gravity fed canals, and pumping plant projects which lift water from a source below the paddy to a level high enough to allow irrigation canals to carry the water to the paddy. Of the 34 irrigation projects currently being funded at the federal level, 32 are either pumping plants or reservoir. The remaining two are infiltration gallery type projects.

One of the basic economic differences between pumping plants versus reservoir is that the installation cost per unit for reservoir is higher than pumping plants. Table 3-3 displays the actual and planned costs per hectare of benefit area for both pumping plants and reservoirs. Only in 1970 did pumping plant installation cost per hectare exceed that of reservoir.

Table 3-3: Installation Cost Per Hectare of Benefit Area

Unit: Won

	1969	1970	1971	1972	1973
Pumping	142	558	409	572	381
Reservoir	202	302	578	972	423

Source: Plans for Land and Water Development Projects, MAF, 1972 (In Korean).

It is also true that yearly operating costs of a pumping operation are much higher than those of a reservoir so that a relatively large portion of the irrigation fees go toward covering operating costs in the case of water pumping. Water pumping operation costs can be reduced considerably with widespread use of electric motors. In what follows, we will partition irrigation projects into two groups; pumping and reservoir. Most of the data available are partioned in this fashion and it also makes homogeneous grouping possible. The geographical characteristics of areas which have pumping plants for irrigation purposes are essentially similar, as are areas with reservoirs. For purposes of completeness, the infiltration gallery projects will be listed but the limited number of them, two, is too small for statistical analysis or comparisons.

Information about the 34 ADC projects which will be useful in the analysis is listed in Tables 3-4, 3-5, and 3-6. The first two columns are displayed on a unit basis while the third column lists total costs so the reader can conceptualize the relative size of each project. There is a considerable variation in the size of each project and, as we would expect, no correlation between size and benefit-cost ratios. The columns headed construction cost, starting date, and percent complete would be of interest to potential foreign donor and loan agencies. The combination of starting date and percent completion should be a fairly good indication of how serious the Korean government is about completing the various projects. The benefit-cost ratios are, in general, quite high indicating very high internal rates of return. Many foreign lenders (e.g., IBRD) view the money spent in partially completing a project as sunk costs and, therefore, consider only the marginal cost of completion as the cost of the project. It is very likely that most of the projects listed in Tables 3-4, 3-5, and 3-6 would be quite attractive candidates for foreign loans if costs are calculated as described above.

In addition, there is substantial indication that costs of domestic construction can be reduced. As far as we know, no comparative data on irrigation construction _per se_ are available, but such data does not exist for paddy rearrangement as between ROKG and UNDP project costs. These data are displayed in Table 3-7 and just a glance indicated rather surprising cost differences. The leveling operation shows the smallest unit cost difference with ROKG standard unit costs being 60 percent higher than UNDP. The road, canal, and drain component difference is the greatest with ROKG unit costs 99 percent higher, and top soil component next with government costs being 94 percent higher than those of UNDP. The per hectare costs do not display quite so large a difference but still much larger than one would expect. In discussing this problem with UNDP officials, they indicated that the bulk of the

Table 3-4: ADC Water Reservoir Projects Under Construction

Province Gun (Project Name)	Yield Increase Per Hectare (M/T)	Const. Cost Per Hectare (Million Won) (1971 Prices)	Const. Cost (Million Won) (1971 Prices) 1/	Starting Date	Percent of Budgeted Funds Expended 1971.12	B/C 1/
Kyenggi Do						
Pyeongtaeg Gun (Chung Yong)	1.27	.49	135.5	68.12	32	2.31
Ganweon Do						
Cheolewon Gun (Cheolewon)	1.50	.27	869.3	66.6	56	3.18
Hongcheon Gun (Whacheon)	1.89	.76	152.3	69.12	45	2.59
Chungcheon Bug Do						
Ogcheon Gun (Dongie)	1.65	1.03	802.2	67.8	16	1.85
Chungcheon Nam Do						
Gongju Gun (Chungan)	1.54	.69	177.3	68.11	43	2.17
Cheonweon Gun (Upsung)	1.40	.88	210.0	65.12	96	1.60
Jeolla Bug Do						
Oggu Gun (Mi Myun)	3.17	1.38	582.2	65.7	88	2.69
Wanju Gun (Ann Huck)	2.02	.64	128.5	70.10	28	3.24
Jeongeub Gun (Kooduck)	1.90	.44	133.6	70.11	31	2.84
Jeolla Nam Do						
Haenam Gun (Buckpyung)	1.31	.70	97.4	70.8	96	2.03
Seungju Gun (Baeyong)	1.30	.87	349.3	70.12	13	1.57
Gurye Gun (Gooman)	1.85	.57	295.0	70.	44	3.04
Haenam Gun (Ohryu)	1.55	.79	118.4	71.5	22	1.99
Gyeongsang Bug Do						
Gunwi Gun (Naiei)	1.00	.34	19.6	70.10	100	2.17
Sangsu Gun (Kongsung)	1.70	.69	686.0	71.5	2	2.55
Gyeangsang Nam Do						
Haman Gun (Myung Kwan)	1.74	.66	176.5	70.	44	2.49

1/ Original B/C Ratio.

Source: "Pla.s for Establishment of Agricultural Production Base," MAF, 1972.

Table 3-5: ADC Water Pumping Projects Under Construction

Province Gun (Project Name)	Yield Increase Per Hectare (M/T)	Const. Cost Per Hectare (Million Won) (1971 Prices)	Const. Cost (Million Won) (1971 Prices)	Starting Date	Percent of Budgeted Funds Expended 1971.12	B/C 1/
Kyenggi Do						
Paju Gun (Changpa)	1.08	.43	117.3	70.9	61	2.41
Ganghwa Gun (Kyo Dong)	1.62	.53	314.9	67.12	11	3.02
Paju Gun (Imjin)	1.26	.34	242.6	70.8	42	2.33
Kimpo Gun (Shingock)	1.91	.44	3,682.0	71.	12	2.73
Yeoju Gun (Neongsuh)	1.49	.29	597.1	66.	24	2.97
Chungcheon Bug Do						
Chungju Si Gun (Kumdong)	2.92	.39	378.6	70.8	22	5.53
Chungcheon Nam Do						
Buyeo Gun (Shaido)	1.48	.55	174.0	70.8	46	1.90
Nunsan Gun (Snagwoel)	1.55	.31	34.0	70.8	94	2.70
Buyeo Gun (Changha)	1.58	.31	72.5	71.6	13	3.30
Gyeongsang Bug Do						
Sangju Gun (Maiho)	2.33	.57	312.1	67.6	36	3.08
Yeongcheon Gun (Yongho)	1.87	.69	112.9	70.8	84	2.67
Euiseong Gun (Yongsuh)	1.75	.39	1,145.2	66.11	27	2.78
Andong Gun (Poonggang)	1.31	.47	837.2	66.11	36	2.08
Yecheon Gun (Poongyong)	1.31	.43	716.6	66.10	34	2.15
Gyeongsang Nam Do						
Jinyang Gun (Cheongdam)	1.26	.35	49.7	70.	47	2.50
Jeolla Nam Do						
Shinan Gun (Docho)	1.43	.64	221.6	71.1	15	2.54

1/ Original B/C Ratio.

Source: "Plans for Establishment of Agricultural Production Base," MAF, 1972.

Table 3-6: ADC Infiltration Gallery Projects Under Construction

Province Gun (Project Name)	Yield Increase Per Hectare (M/T)	Const. Cost Per Hectare (Million Won) (1971 Prices)	Const. Cost (Million Won) (1971 Prices)	Starting Date	Percent of Budgeted Funds Expended 1971.12	B/C 1/
Chungcheon Bug Do						
Cheongweon Gun (Weolgock)	1.33	.40	121.0	70.12	88	2.23
Cheongweon Gun (Seopyeong)	1.24	.46	132.7	70.10	62	1.86

1/ Original B/C Ratio.

Source: "Plans for Establishment of Agricultural Production Base," MAF, 1972.

Table 3-7: UNDP-ROKG Comparative Costs of Paddy Rearrangement

Work Component	Unit	UNDP Cost (Won)	ROKG Cost (Won)
Leveling	m^3	60	96
Road, Canal, Drain	m^3	73	145
Top Soil	m^3	117 1/	227 1/
Total Cost Per Ha. 2/	Ha.	130,540	215,962
Total Cost Per Ha. 3/	Ha.	172,309	297,001

1/ Average Distance: 500 m.
2/ Without Top Soil.
3/ With Top Soil.

Source: Unpublished Report: First Report on Project Equipment, Works Completed and Production Costs, UNDP, July, 1972.

cost differences is attributable to method of operating the heavy equipment and strict adherance to a prescribed maintenance schedule for the heavy equipment. The reason we mention this is that if operation and maintenance is a problem in paddy rearrangement (and we believe it is), then it will also be a problem with domestically constructed irrigation projects. Certainly such work components as road building, canaling, and drainage installation are present in both reservoir projects and pumping projects, so costs apparently could be reduced. The point is that probably costs which go into the benefit-cost ratio could be reduced by improved maintenance and operating methods, thus increasing the B/C ratio. The data we use in Table 3-7 are available to the government, and it would seem advisable for the proper officials to at least look into this matter, especially since funds are so limited in Korea.

A Prefeasibility Rule of Choosing More Probable Investments

In principle, the method by which a decision maker should choose between alternative investments is to rank-order the rates of return to each and then take the highest, the next highest, and so on until the investment funds are exhausted. If he were to simply rank-order the historical evidence he has, mistakes could be made about the inferred probability distribution due to a small sample; and rank-ordering raises certain technical questions about hypothesis testing which make it an inferior procedure to the one described below. Imperfections in this procedure arise in two ways. One is if the rate of return to each investment is in error, or conversely, if the cost of capital is fixed and costs or benefits are incorrectly measured. A second imperfection appears when the decision maker is forced to take action without having the returns to all alternative investments available to rank-order.

The first problem endangers every feasibility study, and outside of independently redoing a feasibility study, very little can be done about the problem. In what follows, we will make the assumption that if there is a tendency to bias the benefit-cost ratios by overstating benefits or understating costs, this bias is consistant between pumping projects and reservoir projects. The implication of this assumption is that the difference between, say, the average B/C ratio in reservoir projects and the average B/C ratio in pumping projects will not reflect the bias. We hasten to point out that no evidence of such a bias has been found; but for those more skeptical readers, the results which follow hold even if the bias is present so long as it is consistent If it is not consistant between types of projects then the results presented will be questionable. Little of an analytical nature can be done to solve this problem, so we have attempted to avoid the problem by safeguarding our results as much as possible from it.

The second problem we hope to deal with more constructively and in a way which will provide help to decision makers in dealing with the difficulty of not having all or even a substantial number of the alternative investments at hand. The method that will be proposed does not substitute for or eliminate the need for feasibility studies, but rather it should make the feasibility study more effective by bringing a priori information to bear on the problem of deciding where to do the various feasibility studies.

The method we will use to solve this problem will be to view the decision of how best to divide feasibility studies done in a particular period between potential pumping type projects and potential reservoir type projects. 1/ The number of different types of projects can be expanded with no problem should that become necessary at some future time. If the objective is to maximize the number of feasibility studies which indicate a relatively high rate of return, one way is to direct feasibility efforts toward types of projects which historically have been relatively high rate of return projects. The question becomes one of determining which rule one follows to accomplish the objective of finding the best investments.

Before a rule of allocating feasibility studies between potential pumping projects and potential reservoir projects can be postulated, it must be established that they are different in some economically meaningful sense. Since benefit-cost ratios provide a rather natural and useful economic measure of investment in water resources we will use that ratio to settle the question of whether pumping projects are different from reservoir projects.

From Tables 3-4 and 3-5, various summary statistics have been calculated and displayed in Table 3-8. As we would expect, average yield per hectare is not statistically different between pumping and reservoir type projects. Rather, the source of differences, if they exist, appear in construction costs per hectare and again as expected,

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1/ We will not consider Infiltration Gallery projects because of the small sample size.

Table 3-8: Summary Statistics on Pumping and Reservoir Projects

	Pumping	Reservoir
Average B/C Ratio	2.796	2.365
Variance of B/C Ratio	.598	.259
Average Yield/Ha. (M/T)	1.650	1.659
Variance of Yield/Ha.	.203	.248
Average Cost/Ha. (Mil. Won)	.455	.720
Variance of Cost/Ha.	.014	.078

reservoirs cost more per unit of benefit area to construct. 1/

The equality of variances in cost per hectare between pumping projects and reservoir projects was tested so we could track down at least part of the source of variation in the benefit-cost ratios since formal analysis of variance was not possible. Clearly, construction costs are only part of the costs which comprise the denominator of the B/C ratio. Operating costs are also discounted back to the starting period and added to construction costs. It is to be expected that the operating costs of pumping projects vary more than those of reservoir projects. This opposite relationship between the respective variances of construction costs and operating costs will tend to make the variances of the B/C ratios between pumping and reservoir projects equal if the variance of operating

1/ The procedure used to make this test was to first test the hypothesis that the variances were equal, which was rejected. This presented a problem of calculating the degree of freedom for the student's t statistic, but the difference between means was so large that even using a lower bound on degrees of freedom the null hypothesis was rejected at the one percent level by a large margin.

costs, after discounting, is large enough to offset the variance of construction costs.

A test of this hypothesis, that the variances of pumping and reservoir B/C ratios are equal, is accepted at both the five and one percent levels.

The reason for the above test for equality of variances was to determine if a valid test could be made of whether there is a difference in B/C ratios between pumping and reservoir projects. We have established that the source of the difference, if it exists, is in costs and not in benefits since yields are about the same. Now the question is, does this difference in costs create a statistically perceptible difference in the mean B/C ratios between pumping and reservoir projects. The answer is yes, it does. The test shown in Table 3-9 indicates that the average B/C ratio for pumping projects is greater than the same ratio for reservoir projects. 1/

We now know something more about the relationship between benefit-cost ratios of pumping and reservoir projects; and this new information can be used by decision makers in a way which will reduce the risk of an incorrect or suboptimal decision. 2/ The mechanism by which this new information helps the decision maker is by informing him that if he were to bet, in the form of a feasibility study, on one type of project having a higher B/C ratio than the other, he should bet on pumping type projects. This would be a good strategy if he had only one or two projects to bet on. But suppose he has a way of betting on several projects. It would probably be an inappropriate strategy to bet all his money on pumping type projects to the complete exclusion of reservoir type projects. In this context, we can think of the feasibility study as

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1/ Interestingly, the same phenomenon has been observed in Taiwan according to members of the staff of the Joint Commission on Rural Reconstruction.

2/ Suboptimal in the sense that the decision maker is not maximizing the average B/C ratio of all investments after discounting for risk.

Table 3-9: Test of Pumping and Reservoir B/C Means

	Pumping Project		Reservoir Project
Mean	2.796		2.365
Variance	.035		.017
Pooled Variance		.055	
Calculated t Value		1.849 1/	

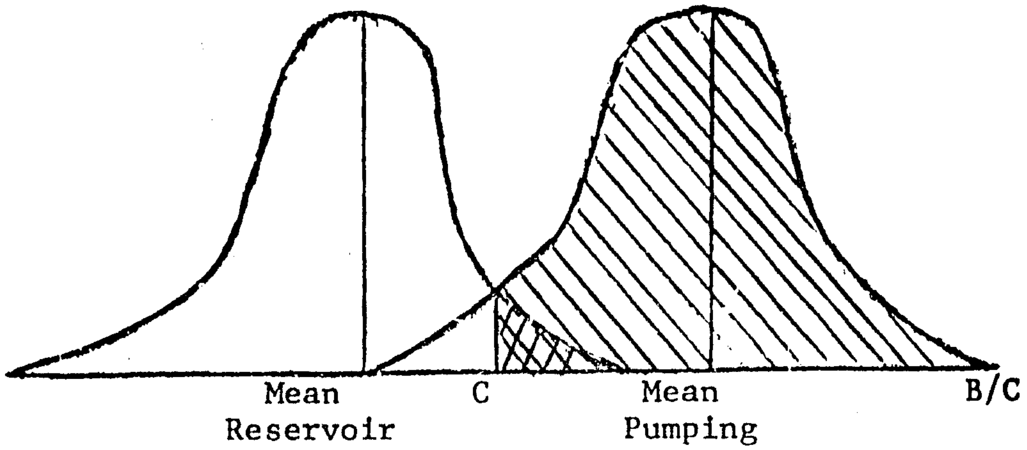
1/ Significant at the five percent level.

the bet and the B/C ratio as the payoff whereby the decisions maker will want to maximize the sum of his payoffs. Some reservoir projects have a higher B/C ratio than some pumping projects, as can be seen in Tables 3-4 and 3-5. Clearly, particularly promising reservoir projects should not be excluded from the set of possible projects. Figure 3-1 illustrates why one must be careful about how bets or feasibility studies are distributed. The point C in Figure 3-1 represents the value at which reservoir projects are a better bet than pumping projects. That is, at point C the probability of a reservoir B/C ratio being greater than C is larger than the probability of pumping B/C ratio being smaller than C.

A rule by which the decision maker could take this fact into account would be to allocate feasibility studies according to the appropriate areas under the frequency distributions. Let the area under the pumping frequency designated by parallel lines be the proportion of feasibility funds earmarked for studies of potential pumping projects, and the proportion represented by the cross-hatched area be the proportion earmarked for potential reservoir projects.

To implement this rule we assume (a) that the B/C ratios for both types of projects are distributed approximately normal, (b) that the pooled variance of the original

Figure 3-1: Frequency Distributions of
Pumping and Reservior B/C Ratios



observations is the true variance (.44), and (c) the estimated means are the true means. With these assumptions we can determine the number C, which turns out to be half the distance between the two means, and we can determine the two areas referred to above. This calculation is shown in Table 3-10 along with the determination of the proportion of funds to be allocated to pumping type project feasibility studies and the proportion to reservoir type projects. As indicated in Table 3-10, our analysis implies about a 60 percent to 40 percent split in funds to pumping and reservoir feasibility studies, respectively. If we can assume that the proportion of feasibility studies by type of project is approximately the same as actual projects started, then the proportion of feasibility studies carried out in the past has been the reverse of the recommended proportions. That is, about 57 percent of the projects (between pumping and reservoir) in progress as of 1970 were water reservoir projects. 1/ We would expect the average B/C ratio of pumping and reservoir projects to increase if a rule similar to the one described above were followed.

1/ Agricultural Development Corporation, Statistic Yearbook of Irrigation and Reclamation, Seoul, 1971, pp 26-27

Table 3-10: Method of Determining Distribution of Feasibility Studies

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To determine C:

$$\frac{C-2.796}{.664} = -z \quad \text{and} \quad \frac{C-2.365}{.664} = z$$

z is a standardized normal deviate. Then:

$$C = \frac{2.796 + 2.365}{2} = 2.581$$

To determine cross-hatched area:

$$P\left(Z < \frac{2.581 - 2.796}{.664}\right) = P(Z < -.325) = .37$$

Therefore, the proportions are:

37 percent for reservoir feasibility
63 percent for pumping feasibility

A point needs to be made here that the rule for deciding how to allocate feasibility studies between pumping and reservoir projects described above and in Table 3-9 is obviously an arbitrary one and others can be conceived which may more satisfactorily take account of the constraints on an individual decision maker. The point, however, is that any reasonable rule will indicate that more attention should be paid to pumping type projects than to reservoir type projects. It is the degree of increased attention that is arbitrary, not the fact that increased attention should be paid. Pumping projects, according to the above analysis, are, on average, better investments and this fact should be recognized in the way new investments are searched out.

It is also true that the reason reservoir project are somewhat less attractive as investments is because more reservoirs have been built and the marginal efficiency of that type of investment has declined both absolutely and relative to pumping type projects. If more attention is paid to pumping as an investment, the same thing will happen: the relative marginal efficiency of investments in pumping will decline. Clearly, no hard and fast rule can be established; but, rather, as this decline becomes empirically evident, the rule or rules should be adjusted accordingly. The analysis used to determine the rule should, however, remain the same as every successful decision maker knows.

Institutional Financial Arrangements

As we mentioned in the previous chapter, because of debt burden, considerations financing part of these irrigation projects with foreign capital is not necessarily the obvious choice. If, however, foreign financing is the choice, then the question arises whether an Ad Hoc arrangement of handling the funds is adequate, or if a more formal institutional arrangement is preferred. Given the outstanding success of the Taiwan model, we think a more formal institutionalized arrangement is preferred to the less formal ad hoc procedure.

According to the Taiwan model, a single organization is designated to handle all loans and grants for medium size development projects. The provincial government is the guarantor of the loan and also has auditors which are independent of the designated organization to audit and assure proper disbursement of funds. In talking with the Chinese, they stressed the importance of (1) a well recognized hierarchy of responsibility, and (2) a well planned work schedule by which funds are dispersed.

The first of these will come as a result of institutionalizing the handling of foreign loans. The second is by no means automatic and must be very carefully incorporated into the thinking of the organization set up to handle the dispersement of funds. Progress must be very carefully verified by investigators from the responsible organization and when work plans are not being met, funds should be withheld until the deficiencies are corrected. The loan should be placed in a government bank jointly in the name of the organization doing the project and the organization designated by the government to be responsible.

In Korea the most logical organization to handle foreign loans would be the Farmland Bureau of the Ministry of Agriculture and Forestry (MAF). The importance of separating the function of supervising fund disbursements from doing the project work cannot be overstated and eliminates ADC from consideration as an administrator of foreign loans. This separation is important for the two reasons given above: first, the role of planning and maintaining a work schedule is separated from supervising the completion of that schedule; and second, the separation of responsibilities must be clear and distinct. Once projects are completed they should then be turned over to the responsible irrigation association.

Under a scheme of this sort, responsibility will be well defined. The Farmland Bureau will be responsible for administering the loan, and an organization such as ADC will be responsible for executing the project. Investigators from the Farmland Bureau will be responsible for assuring that organization of the work and the plan for disbursement of funds is being carried out according to the schedule negotiated at the time of the inception of the project. They will also be responsible for auditing the project finances in accordance with usual proceedings of internal accountability. Obviously, control is considered of paramount importance and guidelines for authorized use of funds as well as a mechanism for allocation and distribution of funds must be carefully thought out and instituted.

A second point with respect to finance is the pricing system used for irrigation water. At present the unit price is placed on a hectare of water which has no built-in incentive to conserve water over a growing season. There is a period of time in the early summer when water is in short supply, particularly if the rainy season is late or short. If water were priced by the cubic meter or by some other flow unit (e.g., minute of open head gate), there would be more of a tendency to conserve water. A little conservation would solve the water shortage problem in all probability.

It is probably not feasible to arrange water measuring devices for each farmer, but it would certainly be feasible for such devices to be installed for groups of farmers. The local irrigation association could control the head gates and let the farmer manage his water more carefully or pay a higher than necessary water charge Such a system is being successfully used in Japan as well as other more arid countries where water is extremely expensive.

Summary

Korea is now, and will continue to be in the future, heavily engaged in irrigation projects of the pumping and reservoir variety. At present, there are 34 such projects now under construction which are being financed through the central government. These 34 projects are in various stages of completion and all have favorable B/C ratios. Many of these projects would provide an excellent object of foreign investment loans. This is particularly true of the foreign agency views the marginal cost of completing the ongoing project as the total cost. It also would appear that some improvement in construction costs would be possible.

A prefeasibility investment rule was devised with the objective of increasing the average B/C ratio of government sponsored projects. It was found that, on average, pumping projects are better investments than reservoir projects and that if feasibility studies are allocated between potential pumping and reservoir projects on a 60 percent to 40 percent basis, rather than the reverse as has been the case, the average B/C ratio would increase.

Chapter 4

Drainage

The problem of water management comes up in a variety of ways in Korea, one of which is properly draining water from the rice paddies. The most obvious way in which drainage is needed is to remove excess surface water from the paddy at a certain growing stage of the rice plant. This is accomplished by allowing the water to drain off the paddy and by the water percolating through the superficial layers of soil and into the subsoil. Drainage ditches located below the paddy handle the surface water drained off and the water which seeps into the ground eventually goes to the water table. Clearly, the paddy cannot be completely drained unless the water can seep through the superficial layer of soil and into the subsoil. The paddy will remain wet for extended periods of time stunting the growth of the rice plant which in turn reduces the productivity of the land. On the other hand, the water level of the paddy cannot be properly managed unless drainage ditches are available to accept runoff. Both of these drainage problems are important but the drainage of surface water into drainage ditches has received much more attention. 1/ As a result, we will focus out efforts on subsurface drainage, as this problem seems to be the one about which the least is

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1/ Although surface drainage has received much attention, and all government officials seem to be aware of the importance of surface drainage, it is impossible to determine the amount of paddy area which is improperly drained due to lack of drainage ditches to accept the runoff. This problem is independent of soil type and a special survey should be conducted in order to estimate the magnitude of the problem. In this paper, we will be assuming there are drainage ditches to receive the residue of the subsurface drains.

known. In this chapter we will attempt to determine the amount of land which would require subsurface drainage, estimate the potential benefit from installation of drainage, and economically compare the various methods of subsurface drainage.

The Subsurface Drainage Problem in Korea

Given the existing data base, it is impossible to give an exact estimate of the total amount of land in need of subsurface drainage in Korea. At present, official estimates vary widely. There are three sources of data in existance from which statistical estimates can be used to get some indication of the amount of land in need of drainage. The first source is the Survey of Low Productive Soils in Korea. The classification system used in that survey is shown in Table 4-1. The categories which are known to need drainage are (1) badly drained soils, (2) desaline soils, (3) saline soils, and (4) strongly acid soils. The sum of these categories is 45,207 hectares. Since 100 percent of those soils require drainage, this number can be viewed as a lower bound on the actual number of hectares in need of drainage. The abnormal soils contain some imperfectly drained soil and the sandy gravel soils contain both imperfectly drained soil and poorly drained soil. Therefore, an upper bound will be approximately 215,000 hectares. That is, if we assume all of these two categories need drainage, the most land which could possibly need subsurface drainage is about 215,000 hectares. It would appear that the figure of approximately 50 percent of the total paddy in Korea needing drainage is much too high. In our interviews with government officials, this was the figure most often heard.

A second source of data is the Plant Environment Research Institute of ORD. They conducted a 100 percent sample of 13 guns around the country shown on the map of Figure 4-1. 1/ These data were collected by taking

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1/ The numbers shown are percent of gun in need of subsurface drainage. The guns distinguished by parallel lines will be explained later in the text.

Table 4-1: Soil Classification of Low Productive Paddy

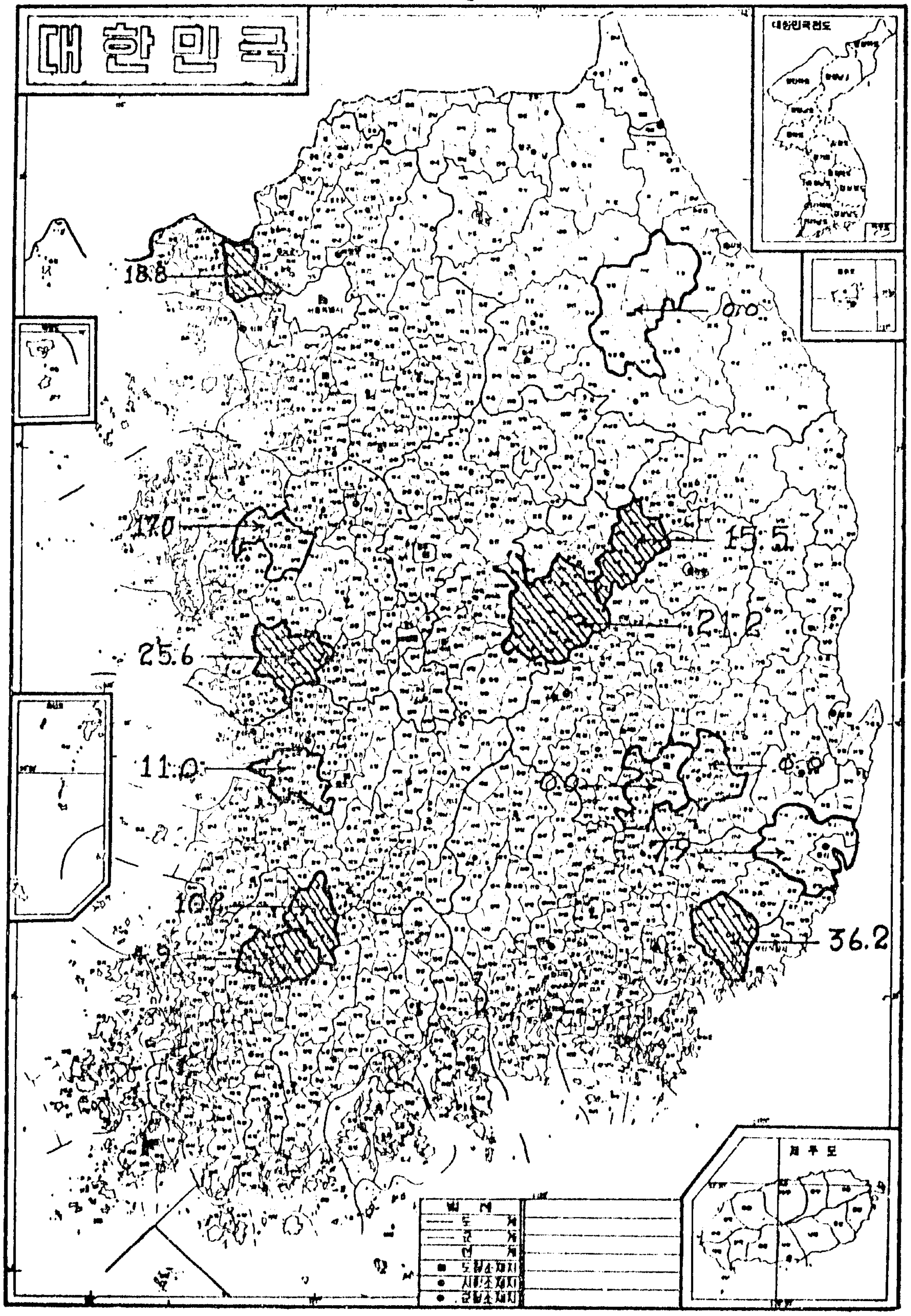
Unit: Hectares

Province	Heavy Clay Soils	Badly Drained Soils	Abnormal Soils	Sandy Gravel Soils	Desaline Soils	Saline Soils	Strongly Acid 1/	Total
Kyenggi	2,522	190	11,277	5,849	1,855	4,315		26,008
Ganweon Do	580	715	6,365	5,140	---	---		12,800
Chungcheon Bug Do	1,400	250	10,305	6,330	---	---		18,285
Chungcheon Nam Do	2,581	3,980	9,460	7,485	516	4,571		95,933
Jeolla Bug Do	1,840	440	11,210	7,270	4,220	2,070		27,050
Jeolla Nam Do	2,130	390	8,310	9,770	970	5,980		27,550
Gyeongsang Bug Do	8,090	8,255	20,560	19,830	200	520		57,455
Gyeongsang Nam Do	2,580	1,910	10,190	9,690	430	580		25,380
Total	21,723	16,130	97,677	71,364	8,191	18,036		290,461

1/ Provincial totals not shown in original source

Source: Survey of Low Productive Paddy In Korea, ORD, 1967.

Figure 4-1: The Eleven Gun Sample with Percent in Need of Drainage



a soil sample every 100 meters, so the accuracy should be quite satisfactory. Under the direction of the Office of Rural Development, the Plant Environment Research Institute (PERI) has finished detailed soil surveys of 25 areas (cities and guns). Complete data is not yet available, however. In addition, detailed soil surveys of the four river basins as well as demonstration areas along the superhighways are under way. At present, data on the 25 guns are not available. Completion of this detailed soil survey will provide very accurate data in the near future. In the 13 gun sample, the soil was classified into a variety of technical categories; three of which, according to PERI scientists, need drainage quite badly. 1/ The amount of paddy in these three categories, by gun, (and the percentage each category is of total paddy in the gun) is shown in Table 4-2. The total wet paddy in the sample is 15,865 hectares or 9.2 percent of the total paddy. The saline paddy is 1,740 hectares or one percent of the sample paddy.

Adding these poorly drained soils comes to 15 percent of the paddy in the sample. Therefore, assuming this sample is representative of the country as a whole, a first rough approximation of the total paddy in need of drainage in Korea is .15 (1,293,710) = 194,056 hectares, well within the bounds we first established with the Survey of Low Productive Paddy in Korea, and the data used is substantially more accurate. 2/

When we say that 15 percent of all paddy is poorly drained, we are giving equal weight to paddy in all parts

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1/ By "badly" we mean double cropping is not possible and the yield effects of the excess water are substantial.

2/ In another study of total paddy in need of drainage it was found that 200,000 hectares needed drainage. See: A Study on the Use of Low and Wet Land by Underdrainage, ADC, Korean Agricultural Engineering Association, 1970 (In Korean).

Table 4-2: Paddy Needing Drainage in a 13 Gun Sample

Unit: Hectares (Percent)

Province	Gun	Wet	Saline	Strong Acid
Kyenggi Do	Gimpo	440 (5.0)	1205(13.8)	--
Ganweon Do	Pyeongchang	--	--	--
Chungcheonbg Nam Do	Buyeo	3555(22.1)	--	565 (3.5)
	Yesan	1625(12.9)	--	510 (4.1)
Jeolla Bug Do	Gimje	1350(5.4)	535 (2.1)	895 (3.5)
Jeolla Nam Do	Gwangju,	600 (4.9)	--	--
	Gwangsan	955 (10.2)	--	--
	Damyang			
Gyeongsang Bug Do	Yecheon	1670(15.5)	--	--
	Sangju	4195(21.2)	--	--
	Daegu,	--	--	--
	Daiseong	--	--	--
	Gyeongsan	--	--	--
Gyeongsang Nam Do	Gimhae	365 (1.9)	--	6300(34.3)
	Ulsan,	1110(7.9)	--	--
	Ulju			
Total		15,865(9.2)	1,740(1.0)	8,270(4.8)

Source: Paddy and Upland Area Distribution by Soil Type and Region, Plant Environment Research Institute, ORD, 1971.

of the country. As a glance at Table 4-2 will show, there is substantial variation from gun to gun in the percent of paddy which needs drainage. Notice that Gimpo, Buyeo, Sangju, and Gimhae Guns all have more than 19 percent badly drained paddy. Investigating these guns somewhat closer reveals that all those areas are within one of four river basins: Han, Yongsan, Nakdong, or Geum. It also seems reasonable that the paddy in these river basins would have a more severe drainage problem than areas outside the basins and the data in our sample bear this out. Guns which lie in one of the four river basins are indicated on the map of Figure 1 by parallel lines. Of all the guns contained in the river basins, only Gwangsan, with 4.9 percent of paddy needing drainage, is unusually low. It would appear that a reasonable partition of paddy for the purpose of estimating the total paddy needing drainage would be to separate the paddy inside the four river basins from that outside, then assume those guns inside represent basin paddy while that outside represents other paddy. By Table 4-3, 18.27 percent of the river basin paddy needs drainage. Since 52.49 percent of all paddy is contained in the four river basins, 9.59 percent of all paddy represents badly drained paddy located in the four river basins and 2.67 percent of all paddy represents badly drained paddy located outside the four river basins. Thus, 124,067 hectares of badly drained paddy is located inside the four river basins and 34,542 hectares are located outside the basins. This implies that Korea has about 158,609 hectares of badly drained paddy.

It is difficult to say which of the numbers given in Tables 4-2 and 4-3 is more accurate based on such a small sample, but they are both of the right order of magnitude. On the basis of the information available, it seems true that river basins are more prone to badly drained paddy than other areas, so the weighting scheme outlined above is reasonable. We are, therefore, inclined to think the amount of badly drained paddy is closer to 158,609 hectares than to 194,056.

Identification of the location of the badly drained paddy is impossible without a complete survey (which is in progress). According to Table 4-3, about 18 percent

Table 4-3: Sample in Relation to Four River Basins

	Inside Four River Basins	Outside Four River Basins
Percent Poorly Drained Paddy in Sample (Average)	18.27%	5.63%
Percent Total Paddy Area In Korea	52.49%	49.51%
Percent Poorly Drained Paddy in Korea	9.59%	2.67%

of the paddy in the river basins is badly drained and about 5,6 percent of the paddy outside is badly drained. Clearly, the bulk of the badly drained paddy is contained in the four river basins which comprise about 52 percent of the total paddy.

The Benefit of Drainage

In 1964 ORD used 174 demonstration plots to determine the yield effect of drainage on wet paddy. These demonstration plots were scattered all over the country so that the test was carried out under a variety of circumstances using traditional varieties of rice. Table 4-4 shows the results of drainage on both wet paddy and saline paddy. The average yield increase was 24 percent on wet paddy and 44 percent on saline paddy. 1/ Table 4-5 shows the results of the same type of experiment on foreign wet and normal paddy. The average increase was 40 percent on wet paddy and 9 percent on normal paddy.

1/ The 44 percent yield increase on saline paddy was determined on experimental plots by ORD and was not determined by the 174 demonstration plots.

Table 4-4: Yield Effects of Drainage on Wet and Saline Paddy in Korea

	With Drainage	Without Drainage
Wet Paddy	439 kg/tanbo 1/	354 kg/tanbo
Saline Paddy	220 kg/tanbo 2/	153 kg/tanbo

1/ One year after tile pipe drainage installed.

2/ Three years after mole drainage installed.

Source: Subsurface Drainage, ORD, 1970 (In Korean).

Table 4-5: Yield Effects of Drainage on Wet and Normal Paddy on Foreign Soil

	With Drainage	Without Drainage
Wet Paddy	479 kg/tanbo	342 kg/tanbo
Normal Paddy	427 kg/tanbo	391 kg/tanbo

Source: Subsurface Drainage, ORD, 1970 (In Korean).

The data in Table 4-4 is quite conservative with respect to wet paddy since only one year was allowed to determine the yield effect, 1964. It usually takes three to five years before the full yield effect occurs because it takes that long for the wet paddy to drain completely due to the impermeability of the soil. Also, we would expect that the yield effect on wet paddy seeded with the new shorter stalk varieties to exceed 24 percent since proper water management is more critical with these varieties. We, therefore, view 24 percent as a conservative estimate of the yield increase due to drainage on badly drained paddy.

A second benefit which arises from drainage is the capability to double crop land which, before drainage, was relatively unproductive single cropped land. Since three of the four river basins are in the double cropping regions of Korea and 77 percent of the badly drained basin paddy lies in these basins, it is clear that double cropping will constitute a very important benefit. Table 4-6 shows how the paddy is distributed among the four river basins relative to national figures.

The total paddy within the river basins which can be double cropped is .77 (.525)=.404 of the total paddy or 523 thousand hectares. Of this amount, 18.27 percent or about 96 thousand hectares is badly drained and, as a result, cannot be double cropped. To calculate the double cropping of paddy outside the four river basins we use the national average of 65 percent of the paddy double cropped. 1/ Assuming the 34,542 hectares of badly drained paddy outside the river basins will be double cropped in a proportion of 65 percent, 22,450 hectares of additional paddy will be double cropped in regions outside the river basins. This yields a total of about 118 thousand hectares of additional paddy which would be double cropped as a result of drainage.

1/ Ministry of Agriculture and Forestry, Yearbook of Agriculture and Forest Statistics, 1971, p.66.

Table 4-6: Distribution of Paddy in Four River Basins

Basin	Paddy (000 Ha.)	Percent of Total Paddy	Percent of Basin Paddy
Han	160	12.3	23.4
Nakdong	305	23.4	44.7
Geum	158	12.1	23.1
Yongsang	60	4.7	8.8

Source: Plans for Land and Water Development Projects, MAF, 1972 (In Korean).

The question of how to evaluate the double cropping effect will be settled by assuming all 118,000 hectares will be planted in barley as the second crop. The gross receipts per hectare of barley in 1970 were 67,300 won implying a value added each year of 7.94 billion won to the social product of Korea. If we extract purchased inputs, the return to land 2/, family labor, and capital from barley production was 35,460 won per hectare in 1970. The first number, gross income or receipts, represents the amount of economic activity generated by the average hectare of barley; whereas the 35,460 won is net income implying 4.18 billion won will be added to net farm income each year if all 118,000 hectares were properly drained.

From Table 4-2 it is clear that most of the paddy which needs drainage is wet paddy. In order to evaluate the increased rice yield effect some assumption must be

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1/ There was only 10 won difference in income per hectare in barley and naked barley so for purpose of this analysis they will not be differentiated. See Report on the Results of Farm Household Economy Survey of Agricultural Products, MAF, 1971, pp.279-295.

made about the distribution of types of paddy in need of subsurface drainage. We have no experimental results on strongly acid paddy so, in the interest of making our results conservative with respect to the benefits of drainage, assume strongly acid paddy has the same yields as saline paddy. 1/ Therefore, we would expect 61 percent of the badly drained paddy to be of the wet paddy variety and 39 percent of the saline paddy variety. Using the results in Table 4-4, this would imply (using 159,000 hectares as the total paddy needing drainage) 97,000 hectares would yield about 4.4 metric tons per hectare after drainage, and 62,000 hectares would yield about 2.2 metric tons per hectare after being properly drained. This works out to be an average yield of 3.5 metric tons per hectare on the 159,000 hectares, about the national average. This amounts to 562,200 metric tons which in 1970 prices has a value of 42.17 billion won. 2/ The estimated value of production without drainage would be 32.87 billion won, again in 1970 prices. The value of the net increase in rice due to subsurface drainage is 9.30 billion won. In total then, if subsurface drainage was installed on all 159 thousand hectares which we estimate needs such drainage, the yearly benefits which arise from the additional double cropping and increased yields of rice are conservatively estimated at about 17.24 billion won value added to the Korean Social Product and about 13.48 billion won increase in net farm income.

It is also worth noting the effect this increase in rice production would have on the rice gap between production and consumption. In 1970, 3.939 million metric tons were produced. The rice gap is commonly reputed to be about 10 percent of production, implying rice imports

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1/ In fact, strongly acid paddy is more like wet paddy if properly drained since the acid is flushed out of the soil before it can harm the rice plant.

2/ Ministry of Agriculture and Forestry, Yearbook of Agriculture and Forestry Statistics, 1971, p.446. The price used was 6,000 won per 80 kg. bag.

were around 394 thousand metric tons of rice. We estimate that the installation of drainage on the 159,000 hectares of paddy which need it will produce an additional 124 thousand metric tons of rice. This amounts to nearly 32 percent of the rice gap in 1970, surely a contribution to closing the rice gap which cannot be ignored

Methods of Subsurface Drainage

There are three ways which will be considered here to accomplish subsurface drainage; mole drainage, open ditch drainage, and tile pipe drainage. The mole drainage method bores holes about seven to nine centimeters diameter approximately one-half to one and one-half meters below the paddy surface, and spaced anywhere from one to three meters apart. The water then flows into the holes and out into a larger drainage ditch which will drain the paddy soil dry or flush acid or saline soil much quicker than would otherwise be the case.

The open ditch method simply digs a ditch approximately one-half meter in width and one-half meter, or slightly more, in depth and the subsurface water seeps into the ditch and flows through the ditch off the paddy. The distance between open ditches will vary depending on soil characteristics and land scarcity, the latter point indicating it would not be particularly popular in Korea because land is so intensively used.

The tile pipe drainage is similar in principle to the mole drainage, except that the hole which carries the water is considered permanent. The pipe is set about one meter below the paddy and separated by about one to three meters depending on the soil characteristics and severity of the drainage problem. The pipes are loosely connected so as to prevent large soil particles from entering the passage but allowing water to seep into the pipe.

Some experimental results were published by ORD in 1970 on these three methods of drainage. Table 4-7 breaks out the various costs of each method on a per hectare basis. The mole method utilized a tractor with attachments and assumed a five year life of the attachments, evaluated at 50,000 won with 5,000 won salvage value. The other costs

Table 4-7: The Per Hectare Costs of Drainage Installation

Unit: Won

Method	Duration (Yrs.)	Labor	Materials & Equipment	Total
Mole 1/	3	30,100	6,500	36,600
Open Ditch 1/	5	55,900	--	55,900
Tile Pipe 1/	30	68,800	50,000	118,800

1/ All costs calculated with 1970 prices.

Source: Subsurface Drainage, ORD, 1970 (In Korean).

going into the 6,500 won per hectare were wages, rent, fuel, repair, etc.

The 50,000 won for materials in the tile pipe method was expenditures for the tile pipes of dimensions 9 cm x 45 cm. The unit price was 50 won per piece of pipe.

There are alternative materials and methods in some instances. For example, some experimentation has been carried out at Agricultural Engineering Research Center of ADC with plastic pipe rather than the tile pipe, but it was found plastic was more expensive than tile. As an alternative to using a tractor to bore the holes in the mole method, a winch can, and is, being used. The winch can be driven by a five horse power motor, indicating that rototillers, which will become more common in the Korean countryside in the coming years, will be sufficient as a power source.

The data shown in Table 4-8 was given to us by a rather enthusiastic farmer and, therefore, should be regarded with the proper caution. The big difference appears in labor costs, which make the winch method much cheaper. It is also worth noting that assuming a 30 day working year 120 tanbo or 12 hectares per year can be completed while the data collected by ORD, say about 53 hectares per year, can be completed. These two figures are ordered as one would expect.

Two pieces of data given us by the farmer are probably more important than all others. The first is that in the Gimhae area (the location of the farmer's home), mole drainage lasts 10 years rather than the three shown in Table 4-7. If the 10 year duration of mole drainage in Gimhae Gun is true, it is probably due to especially conducive soil conditions which may not be present elsewhere in Korea. It is probably true that three years is a conservative estimate and that the average duration is between three and ten years. The point to be made here is that three years is not an overstatement of the duration of mole drainage; and if it lasts longer, its costs relative to other methods will decline. The farmer we talked with had 30 years of experience with this type or subsurface drainage, and mole drainage had been adopted by all farmers in the immediate area.

The second piece of data, which has been corroborated from several other sources, is that the full yield effect of drainage is not obtained in the first year or the second, but may take up to four years or more to get the soil which lies between mole drains completely drained of water. The farmer we talked with said it was four years before the rice stalks between drains were as tall as the stalks directly over the drains. Once again, the figures we shall use are conservative on the benefit side since the 24 percent yield increase was based on yield results after the first year drainage was installed. It may also be worth noting that ORD spaced the drains three meters apart, whereas the Gimhae farmer spaced his about 1.8 meters apart.

To make economic comparisons of the costs of various methods, we have compared the discounted 30 year costs of the mole and open ditch methods to the cost of the tile pipe method which is conservatively estimated to last 30 years. Table 4-9 lists the present value of all methods over a 30 year period for .10, .18, and .25 discount rates. At the .10 discount rate, tile pipe is clearly the least cost alternative but when the discount rate is increased to .18 or .25, closer to the real investment cost in Korea,

Table 4-8: Daily and Hectare Costs of Using a Winch in Establishing Mole Drainage Systems

Unit: Won

	Units	Daily	Hectare
Machine Depreciation 1/	1	--	1,083
Fuel	--	1,500	3,750
Total Machine Costs	--	--	4,833
Unskilled Labor	4	3,200	8,000
Skilled Labor	1	1,000	2,500
Total Labor	--	4,200	10,500

1/ The total cost of motor, winch, cable, and mole drilling tool was given as 260,000 won. We assumed a 20 year life with no salvage value and straight line depreciation. The farmer indicated four tanbo per day was the capacity, and we assumed there were 30 days per year in which it was possible to operate the equipment without interfering with usual cropping plans.

Table 4-9: Present Values Per Hectare of the Costs of the Methods of Subsurface Drainage Over 30 Years

Unit: Won

	Duration	Discount Rate		
		.10	.18	.25
Mole Method	3	138,740	92,865	74,907
Mole Method	6	79,220	57,730	49,542
Mole Method	10	56,151	44,929	40,952
Open Ditch	5	138,012	98,616	83,042
Tile Pipe	30	118,800	118,800	118,800

mole drainage is the superior method from a cost point of view. Also, notice that mole becomes relatively lower cost compared to open ditch as the discount rate is increased. To the extent that three years duration underestimates the real duration of mole drainage, it becomes even more attractive at .18 and .25 discount rates, and at .10 discount rate it begins to compete with the tile pipe method as the duration period gets longer.

Table 4-10 shows the rate of return at which the cost of tile pipe is exactly equal to the cost of the other two methods properly discounted. Since there is only one rate of return which equates these costs, 1/ the mole method and open ditch method can be viewed as costing less than the tile pipe method at all interest rates greater than those shown in Table 4-10.

Table 4-10: The Rate of Return Which Equates the Cost of Tile Pipe Versus the Mole and Open Ditch Method

	Duration	Tile Pipe
Mole Method	3 years	126 %
Mole Method	6 years	42 %
Mole Method	10 years	< 0
Open Ditch	5 years	131 %

We are now in a position to assess whether drainage of any kind is a worthwhile investment; and, if so, which methods can profitably be used. From Table 4-4 we can calculate that the rice yield increases .85 metric tons per hectare on wet paddy and .67 metric tons per hectare

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1/ The rate of return equation had only one solution or root.

on saline paddy. Since 61 percent of the paddy is estimated to be of the wet variety and 39 percent the saline variety, the weighted average yield increase is expected to be about .78 metric tons per hectare. In 1970 prices, the value of a metric ton of rice is 75 thousand won implying the value of the increased yield of rice as a result of drainage would be about 58,500 won per hectare. 1/ Thus, the benefit from the increased rice yield is very substantial without considering the double cropping possibilities.

To assess the benefit of double cropping we need only recall that the income net of production costs for one hectare of barley was 35,460 won; so the total per hectare benefit on paddy which can be double cropped will be 93,960 won. Notice from Table 4-9 that one year of benefits exceeds the present value of 30 years of costs using the mole method and a discount rate of .18 or .25.

Table 4-11 lists the benefit-cost ratios of the various methods of drainage for three discount rates, .10, .18 and .25 for double cropped paddy while Table 4-12 is for single cropping. Everything was calculated using a thirty year cycle so the B/C ratios are comparable. Clearly, the mole method is superior to the other two methods in most cases, but these ratios are so high that any method, except possibly open ditch, would be acceptable and all methods would be profitable. The open ditch method is not particularly viable because of the extra land which is used as a result.

We have made these calculations using three different discount rates. There are two reasons for this. The three discount rates give the reader an idea of how the B/C ratios behave as the discount rate changes. These three points, along with the rate of return which equates the B/C equal to one, describe reasonably well the line in the B/C-discount rate plane. 2/ A second reason is

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1/This is a net figure since no additional input costs are incurred after drainage is installed.

2/The function is monotone in the relevant space since no multiple roots were encountered.

Table 4-11: Benefit-Cost Ratios of Drainage With Double Cropping Pattern

	Discount Rate			Interval Rate of Return B/C=1
	.10	.18	.25	
Mole Method (3 yrs.)	6.38	5.58	5.01	> 200 %
Mole Method (6 yrs.)	11.18	8.98	7.58	> 200 %
Mole Method (10 yrs.)	15.77	11.54	9.17	> 200 %
Open Ditch (5 yrs.)	6.37	5.26	4.52	167 %
Tile Pipe (30 yrs.)	6.46	4.36	3.16	79 %

Table 4-12: Benefit-Cost Ratios of Drainage With Single Cropping Patterns

	Discount Rate			Interval Rate of Return B/C=1
	.10	.18	.25	
Mole Method (3 yrs.)	3.97	3.48	3.12	150 %
Mole Method (6 yrs.)	6.96	5.59	4.72	159 %
Mole Method (10 yrs.)	9.82	7.18	5.71	160 %
Open Ditch (5 yrs.)	3.97	3.27	2.81	102 %
Tile Pipe (30 yrs.)	4.64	2.72	1.97	49 %

to indicate economic feasibility at three discount rates which are meaningful in terms of cost of capital under different circumstances. The .10 discount rate is in the neighborhood of the cost of capital if borrowed from international donor agencies or subsidized by government. The .18 discount rate is similar to the cost of capital from commercial banking institutions, whereas the .25 discount rate is in the general range of private capital cost.

In the interest of conservatism, let us assume that all benefits were overstated by 100 percent and costs were understated by half their actual value. If we calculate the B/C ratios using these very conservative assumptions for single cropping rice only, we have effectively assumed a yield effect of 12 percent due to drainage and costs that are twice those listed in Table 4-7. Using these assumptions, Table 4-13 lists the B/C ratios for each method using discount rates of .10, .18, and .25. The column headed B/C=1 lists the rate of return for which the B/C ratio is one. Clearly, the ratios given in Tables 4-11 and 4-12 are not accidental; the results are quite insensitive to anything but very large and radical changes in costs and benefits.

We don't think these results need special comment; the numbers given in Tables 4-11 and 4-12 speak for themselves -- subsurface drainage appears to be an excellent investment from both a public and private point of view. The rate of return which equates the B/C ratio to one in Table 4-13 in all cases is probably less than the cost of capital if the funds came from an international loan agency such as IBRD or USAID. Whether or not this appearance is an illusion can only be determined by more technical experimentation and research on yield effects and costs of installation. We recommend this research begin as soon as possible, and that both technical experts and economists be consulted when the experiments are designed. The data used in this report can be criticized on many counts, most of which involve lack of comprehensive and systematic experimentation. We hope this will not be the case in the future. It would appear that with the new short stalk varieties there is a good chance that drainage is

Table 4-13: Benefit-Cost Ratios of Drainage Under Conservative Cost and Benefit Assumptions Single Cropping

	Discount Rate			Internal Rate of Return
	.10	.18	.25	B/C=1
Mole Method (3 yrs.)	.99	.87	.78	10 %
Mole Method (6 yrs.)	1.74	1.40	1.18	33 %
Mole Method (10 yrs.)	2.46	1.80	1.43	36 %
Open Ditch (5 yrs.)	.99	.82	.70	10 %
Tile Pipe (30 yrs.)	1.16	.68	.49	11 %

an even better investment than is indicated above. Good research can bring this hypothesis to a clear test, and the cost of that research compared to the potential payoff is very small indeed.

Financing Drainage

Ignoring the possibility of outright grants and personal savings there are three ways of financing the installation of drainage. One would be the private loan market with its extremely high interest rates, a government loan with its relatively low and fixed interest rates, or an international loan to the government with the funds earmarked specifically for financing subsurface drainage.

The private loan market is quite feasible given the internal rates of return shown in Tables 4-11 and 4-12; but given the cash flow problem and the very high interest rates, much of the incentive is lost.

A more usual channel would be through NACF which would be desirable if sufficient funds could be made available. This channel is well organized and the only additional administrative task to be carried out would be to formally recognize subsurface drainage as a legitimate use of government loan funds. There are, of course, a variety of ways these loans could be made. They could be made directly to an individual farmer who could install his own drainage; and since many of the farmers in his area would also need drainage, he could rent out the equipment to help pay for it. 1/ Another alternative would be to make the loan to some sort of cooperative group which would in turn be responsible for the retirement of the loan. Since subsurface drainage is rather small scale relative to most investments in Korea, these suggestions seem particularly relevant. Another possibility would be for the local irrigation association to buy the equipment and rent it to members who need drainage as well as give technical assistance when needed.

A third way of getting loanable funds for subsurface drainage would be from international sources. If specially earmarked funds were loaned to the government, the interest rate could be marked up sufficiently to cover the additional administrative and technical assistance cost without making the loans to individuals, groups, or irrigation associations unattractive as a result. Again, the only problem here is additional foreign debt burden which must be considered; but if the true costs and benefits of subsurface drainage are anything like what has been calculated above, it should be one of the first investments made whether foreign funds are used or not.

Summary

We have estimated the total paddy in need of subsurface drainage to be between 159,000 and 194,000 hectares. The yield effect has been conservatively estimated at a 24 percent increase as a result of the installation of subsurface drainage. Drainage needs are much more

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1/ We are assuming mole type drainage here since that would appear to be the most economical.

prevalent in the four river basins (18 percent of paddy in these areas) than in the non-river basin areas (6 percent). Taking this fact into consideration and the fact that, as a result of drainage, double cropping can be carried out, about 17 billion won will be added to Korean Social Product with about 13 billion won of additional farm income.

Using the least cost method of subsurface drainage yields a B/C of about 6 for double cropping patterns and about 4 for single cropping patterns at an 18 percent discount rate. An indirect public cost not included in these calculations is the additional extension effort required to provide farmers with new knowledge of water control management techniques and operation and maintenance of drainage facilities. Also not considered is the additional labor requirement for the farmer and his family.

Subsurface drainage loans can be easily handled within existing institutions and would provide the irrigation associations with an opportunity to be of greater service to their members by renting the necessary equipment and providing technical assistance to install drainage. Loans could be provided the irrigation associations through existing financial institutions. In addition, subsurface drainage can be developed on a small scale without the large risk and inefficiencies which naturally come along with larger scale development projects.

Chapter 5

Upland Development 1/

In this chapter we will consider the economic feasibility of developing Korea's uplands for agricultural production. In order to investigate analytically we must consider both the anticipated demand for land among competing uses, and the potential supply of land resources.

Anticipated Demand: Why Upland Development?

Korea's demand for land resources and for the products of land reflects its status as a rapidly developing nation. There are, however, many conflicting factors which come into play when estimating this demand.

First, Korea's population is growing very rapidly. Land resources must feed, clothe, and house a resident population of about 30 million, double what it was at the end of World War II. David Smith, of the Population Council, estimates that with a moderate fertility variant, the population will reach 41.8 million by 1985.

The rate of population growth is decreasing as Korea moves toward population stability. This is due to many factors including (1) increased urbanization, (2) increased levels of real income, (3) rising levels of educational attainment, and (4) changing age structure, all of which lead to smaller families. While this prospect for population stability will have a beneficial effect in helping to ease the demand for land and the products of land, these same factors will have a contrary effect in further complicating the demand situation.

Although there will be an increased demand for the products of land, increases in real income generally lead to a relatively greater demand for either non-food goods or high-elasticity food commodities (i.e., livestock, dairy, fruits, and vegetables) than for the traditional food products. These are the commodities most easily grown on reclaimed uplands.

1/ This chapter is heavily based on Barlowe et.al., "An Analysis of New Land Development in Korea," KASS Special Report No. 3., AERI-MSU, 1972.

In addition, with urbanization much land will be needed for urban expansion, housing, industrial and commercial sties for streets, parks, reservoirs and urban service areas. While at present 50 percent of the population is urban, it is expected that about 70 percent of the population will live in urban areas by 1981. At the same time, the higher proportion of the population in their productive working years, combined with an extention of life expectancy due to improved medical facilities, will lead to a more than proportionate increase in job opportunities to care for this growing urban work force.

Upland development has the potential of easing this conflict of interest -- the demand for food and the concurrent demand for alternative land utilization. Inevitably, some productive lands will shift out of agriculture. While emphasis should be placed on increasing the technical productivity of present farmlands upland reclaimation can possibly help ease the loss of farmland and, at the same time, provide those high-elasticity food commodities which a population having rising incomes will demand.

Much of the success Korea will enjoy in taking its place among the more developed nations will depend upon the progress it realizes as it marshals its rescurces to meet and fulfill these emerging demands.

Potential Supply of Convertible Resources

Some of Korea's major land resource problems center in the question of whether the nation has sufficient resources to care fo. the type of future it envisions for itself. It would appear that the most likely approach for an increase i.. the productive land base for agricultural production in Korea is to give primary attention to the potential for the development of uplands. which currently have low productivity. In this chapter, we shall discuss the amount of potentially convertible uplands available by province, and consider which crops would be most economically feasible to grow on the varying slopes.

Technical opportunities for new farmlands developments in Korea are great, but economic opportunities are far more limited. Of the 9.8 million hectares of land area, nearly two thirds have been classified as forest land, much of which is bare rock, or suitable only for trees. Nearly all of the area suitable for development as paddy or as terraced uplands has already been developed. Many of the uplands, however, have some potential for growing vegetables, orchard crops, mulberry, forage crops, and trees for fuel and timber. These reclamation activities will produce some high quality lands but, more often than not, will involve the addition of lands that, for some time, will be near the extensive margin for economic use. Intensive use is made of the grass and litter from these areas for fuel and compost purposes. Many of these wild uplands are underutilized, however, in terms of the production potential they could realize with careful management. The nation must, unfortunately, look to reclamation of low quality lands to offset the loss of the often quite productive lands that will shift out of agriculture to higher value uses. Of the 6.7 million hectares of forest land, approximately 95 percent is "reserved forest," leaving 321,000 hectares of convertible forest. Convertible forest is defined as the sparsely forested mountain areas possessing a slope of less than 24 degrees. Within this area, approximately 36,000 hectares are protective forest, leaving a potential land area of 285,739.

It has been estimated that only 70 percent of the total potential land would, in fact, be available for agricultural production due to the inaccessibility of some land and the loss of potential farm use through alternative land uses. By making a 30 percent downward adjustment for each land class and geographic area, this leaves a final 200,000 hectares of land potentially available for development (see Table 5-2, page 78 for provincial breakdown). These areas become the effective land constraints for the linear programming analysis to be discussed below.

About 40 percent of the total convertible land area has a slope of less than 10 degrees; another 40 percent.

with a slope between 10 and 20 degrees; and 20 percent with a slope in the range of 20 to 24 degrees. In terms of land use potential, class C_1 land, with less than 5 degree slope was determined to be suitable for all upland crop production. Class C_2, ranging from 5 to 9 degrees, is primarily suitable for orchards, while Class C_3 land, from 9 to 20 degrees slope, is suitable for pasture and mulberries. Above 20 degrees slope, C_4, the land could be developed for improved native grass and possibly mulberries. Unfortunately, due to the lack of data, the linear analysis below examines only Classes C_1 and C_2.

It is logical that emphasis be given to the potential for developing cropland, but it should be recognized that the potential for bringing in additional land areas is limited. Because of past trends in cropland area, current plans for new upland development, and the impact of increasing demand for urban and industrial lands, highways reservoirs, and possible park areas, the nation may be hard pressed to retain its present area of farmland.

Empirical Analysis

A Regression Model: New land development has had a high priority in the agriculture budget in past years and continues to maintain that priority in the Third Five Year Plan. In fact, during the 1962-1965 period, more than 135,000 hectares of new uplands were added to agricultural production. Although there is a technical limit to the new land that is feasible to develop, there are also certain economic considerations which determine whether or not the land should be used at all, and if so, for which crops.

In order to determine how these economic considerations affect the amount of land in agriculture production, a single equation regression model has been developed. It is a reduced form equation derived from the supply and demand for land which depends on agricultural prices, non-agricultural prices, government investment in agricultural land development, and demographic characteristics of Korea such as population growth and the rapid urbanization over time. The dependent variable, whose variation we seek to explain, will be total land in agricultural use over the period 1955-1969.

The reduced form equation which will be used to predict the total quantity of arable land in use in agriculture is:

$$(1)\ L_t = c_o + c_1 \overline{PF}_t + c_2 \overline{PNF}_t + c_3 \overline{GI}_t + c_4 \overline{FP}_t + c_5 \overline{U}_t + \sqrt{t}$$

where:

L_t = Total land in agricultural use in year t.

$\overline{PF}_t$ = Food price index in year t.

$\overline{PNF}_t$ = Non-food price index in year t.

$\overline{GI}_t$ = Government investment in upland development in year t.

$\overline{FP}_t$ = Farm population in year t.

$\overline{U}_t$ = Urbanization in year t.

$\sqrt{t}$ = A random distribution term.

Economic theory suggests that: 1/

$c_1 < 0$;

$c_2 > 0$;

$c_3 > 0$;

$c_4 > 0$;

$c_5 < 0$.

1/ Barlowe, R; Haley, W.; Kim, B.D.; Ryu, P.R.; and Vincent, W., "An Analysis of New Land Development in Korea," Korean Agricultural Sector Study Special Report 5, Michigan State University, East Lansing, 1972

Even though we cannot determine, for example, the elasticity of demand or supply, we can at least determine if our model is reasonable in a qualitative sense. All signs of the regression coefficients should be as shown above.

Table 5-1 shows the coefficients associated with each variable along with the units of measure.

Table 5-1: Regression Results 1/

Independent Variables	Regression Coefficients	Units of Measure
Constant	1720.94*	---
Food Prices	n. s.	1965=100
Non-Food Prices	4.44*	1965=100
Government Investment	n. s.	1,000 Won
Farm Population	23.14*	1000,000 persons
Urbanization	-5.90*	Percentage
R^2 = .996	D.W.=2.47$^{n.s.}$	d.f. = 9

1/ The independent variable is in units of 1,000 hectares.

* The coefficient is more than two and one-half times its standard error.

As can be seen from Table 5-1, none of the coefficients have an unexpected sign. The coefficients with an asterisk are considered to be statistically different from zero and those labeled n.s. are not significantly different from zero. We find that neither the price of food ($\overline{PF}$) nor government investment ($\overline{GI}$) significantly affect the amount of arable land in use. The high correlation between food prices and non-food prices, coupled with the insignificance of food prices, makes one suspect multicollinearity is a problem. 1/ The fact that no land expansion can be attributed to government investment is more difficult to explain.

Food prices have been increasing more rapidly than have non-food prices. Given that the income elasticity of non-food products exceeds the income elasticity of food products, we would expect the demand for non-food to shift more than the demand for food as income grows. Unless there is a very substantial difference in the elasticities of supply of food versus non-food, this difference in income elasticities would lead to food prices rising slower than non-food prices. Either non-food supply is substantially more price elastic than food supply or excess demand is forcing food prices up or possibly both.

A possible rationale for the apparent land use government investment to significantly affect land use is lack of complementary investment in roads to transport production from the newly developed land to main arteries of transportation. Newly developed land will probably be somewhat less productive, and the costs of production higher, than land already in production. The bulk of this increased cost can be attributed to the increased amount of labor spent on a unit of new land, as it takes longer to get seed and fertilizer to the new field and to transport the product out after harvest. This would seem to be an inconsistent line of reasoning in a labor abundant country like Korea until one considers that labor is more valuable during the times of the year when new land would be planted or harvested than during the times of the year when it is actually developed. The farmer may not be available to cultivate the newly developed land during the peak planting and harvesting periods without sacrificing production on older, more productive land.

The coefficient on non-food prices is positive as expected. As the price of non-food goods increases, consumers tend to demand less non-food goods and more food,

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1/ Food prices were more highly correlated with non-food prices than with land.

causing the demand for land to increase in an effort to satisfy the increased demand for food. In this context, we are viewing food and non-food goods as substitutes in consumption. This is, of course, somewhat of a simplification but it appears to be true in the aggregate.

Both the farm population, which will increase the demand for land, and urbanization, which will decrease the supply of land, have the expected signs. Given the trend in these two variables, both will tend to cause land use to decline. Since 1967, the absolute number of people in farming has declined, and urbanization has proceeded at a very rapid pace. Clearly, urbanization and the concomitant demands for infrastructure associated with its increase will not only compete for land now being used in agriculture but, in nearly every instance, will compete for the most productive land.

Taking the estimates of total population and rural population in 1985 being used by the Korean Agricultural Sector Study team (KASS), Korea will have a total population of 39.48 million with 8.67 million being rural. The $\overline{FP}$ variable will be 8.670, and the $\overline{U}$ variable will be 78.0 in 1985. Since both the government investment variable ($\overline{GI}$) and the food price variable ($\overline{PF}$) were not significantly different from zero, we need not estimate their values in 1985. Assuming that the price of non-food goods will increase at approximately the same rate between 1970 and 1985 as it did between 1955 and 1969, we can estimate the $\overline{PNF}$ variable in 1985. The price of non-food goods increased at a rate of 13 percent per year from 1955 through 1969. By extrapolation, we find that $\overline{PNF}$ will be 373 in 1985. Substituting these values into equation (1) along with the estimated parameter values yields a total of 3.117 million hectares of land in agriculture use, or approximately one million hectares of new land brought into production. Thus, equation (1) produces an untenable result since Korea does not at present have anything near one million hectares of newly developable land that would be physically capable of producing some kind of agricultural product. Clearly, the physical land constraint will force land expansion to stop far short of 3.117 million hectares, and food prices will begin increasing much faster as the physical limitation is approached. Unless food prices are stabilized by importing substantial quantities of food, or new technology increases productivity, we would expect a major adjustment in the price of food relative to the price of non-food goods.

Linear Programming Model: As a problem of allocation of limited resources, a linear programming study was undertaken. It took the current production base as given and examined the feasibility of expanding that base through upland development, given alternative sets of assumptions about output and input prices. Table 5-2 shows the estimated land base by class and province, although only Classes C_1 and C_2 were used in the linear programming model. Attention was paid to the intensive margin in which several crops can be grown with farmers deciding which crop to grow, as well as the extensive margin in which new land can be brought into production given the combination of output and input prices. The resource constraints were conceived as land by capability class, family labor available in each of 10 periods per year, hired labor by the same time periods, national and provincial investment capital, and other constraints imposed on individual enterprises

The following criteria were used in the selection of feasible crop enterprises for the L.P. analysis: (1) a crop would be considered if at least 5 percent of the land area of a province was devoted to the particular crop in 1969; (2) no crop would be considered that could not show a positive discounted cash flow over a 20 year period using a discount rate of 18 percent; and (3) two crops could be considered in combination for production on the same land provided the labor requirements did not overlap in excess of 100 hours in a time period measured as one-tenth of a year. The assumptions used in the second criteria were: (1) current technology, (2) 1969 yields, (3) labor requirements would be treated as non-cash inputs, and (4) three alternative pricing strategies as follows: (a) 1969 prices, (b) 1970 prices, and (c) 1970 prices, plus the further assumption that farmers

Table 5-2: Potential New Land By Province

Unit: Hectares

Province	Land Class 1/				Total
	C_1	C_2	C_3	C_4	
Gangweon Do	---	---	---	---	---
Chungcheon Bug Do	104	1,568	3,845	1,268	6,786
Jeju	7,791	6,004	15,806	13,287	42,888
Kyenggi Do	846	5,932	10,579	2,877	20,234
Chungcheon Nam Do	1,186	6,014	17,341	1,555	26,096
Jeolla Bug Do	1,340	7,144	6,206	892	15,582
Jeolla Nam Do	20,847	12,047	8,358	9,441	50,693
Gyeongsang Bug Do	6,136	1,390	5,498	4,011	17,035
Gyeongsang Nam Do	2,923	4,301	6,246	7,234	20,704
Total	41,173	44,400	73,879	40,565	200,017

1/ The land class definitions are:

C_1: Land with slope of less than 5 degrees.

C_2: Land with slope between 5 and 9 degrees.

C_3: Land with slope between 9 and 20 degrees.

C_4: Land with slope between 20 and 24 degrees.

would receive compensation from the government at the rate of 500 won per day for all labor required in land development, plus one-half of the development cost beyond labor as required through the development process.

In the first phase of the analysis it was assumed that the 1965-1969 reported average yields would constitute an appropriate basis for comparative analysis, and that the gross value be computed by multiplying these base yields by the 1969 prices received. By using the base yields, appropriate prices and costs, and the assumptions pertaining to yield potential with regard to time, the expected gross value stream for each crop in each subregion was computed over a 20 year period as shown in Tables 5-3 and 5-4.

The estimated required investment per hectare for upland development can occupy a very wide range. Considering only land conversion, field ways, and material input requirements, the estimated cost is in excess of 160,000 won per hectare. It was decided, therefore, to exclude land conversion and road development and to look first and foremost at the labor required for land development with and without bench terracing. In addition to labor requirements, development costs required to increase the productive potential of the newly developed land to the level of productivity already experienced on developed land were prorated to the years considered necessary to accomplish this productivity objective. Cash surplus for a farmer is an unusual phenomenon; but even if the farmer has investment capital available, it is quite likely that he would prefer to invest for improved productitivity of his already developed land. Whether or not there are crop enterprises which would yield attractive long term returns is one of the hypotheses which we attempt to test.

The hypothesis has been advanced that there is an inadequate supply of farm labor to permit further land expansion and crop production. It was found in the L.P. analysis that the amount of labor required for cultivation on newly developed land varies with price relationships and differing crop combinations. An average requirement of about 1,500 hours per hectare can be expected. Consequently, for all regions the 1969 supply of labor

Table 5-3: Present Value of Twenty Year Net Cash Flow for Selected Enterprises by Region (W/ha.) 1/

Enterprise \ Region	Kyenggi Do	Chungcheon Nam Do	Double Crop 2/	Ganweon Do	Chungcheon Bug Do	Jeju
Barley	161,831	189,787	185,438	129,736	155,621	118,347
Wheat	111,041	103,687	98,881	81,062	98,033	36,382
Soybeans	45,897	64,000	51,822	64,000	67,619	--
White Potatoes	5,943	--	-1,910	2,324	- 640	--
Sweet Potatoes	--	--	109,202	--	--	133,550
Millet	--	--	46,059	34,440	38,516	75,212
Corn	--	--	--	3,669	--	--
Chinese Cabbage	328,426	311,221	298,085	311,221	318,635	483,158
Radish	435,644	414,876	447,966	419,532	423,472	653,361
Red Pepper	2,702,008	2,311,023	2,371,566	2,222,740	2,550,665	3,193,893
Barley & Chinese Cabbage	525,027	526,240	517,686	475,451	508,531	582,379
Barley & Radish	646,586	639,407	668,147	584,029	614,134	806,427
Wheat & Chinese Cabbage	474,248	463,213	454,808	427,070	451,450	509,314
Wheat & Radish	581,445	553,325	581,606	535,362	556,268	724,479
Soybean & Chinese Cabbage	482,774	400,480	384,707	410,013	421,043	--
Soybean & Radish	516,359	513,647	538,560	518,307	523,695	--
Wheat & White Potatoes	151,829	--	121,348	118,236	132,240	--
Apple	-73,039	-73,833	-74,985	--	-73,844	--
Peach	--	-98,634	-139,933	--	-110,349	--
Grape	649,466	344,989	335,912	--		927,762
Pear	--	-17,717	4,018	--	--	--
Mulberry	155,731	114,105	138,454	140,025	147,878	--

1/ 1969 Prices.

2/ The double crop region includes Jeolla Nam Do, Jeolla Bug Do, Gyeongsang Nam Do, Gyeongsang Bug Do.

Table 5-4: Present Values of Twenty Year Net Cash Flow For Selected Enterprises by Region (W/ha.) 1/

Enterprise \ Region	Kyenggi Do	Chungcheon Nam Do	Double Crop 2/	Ganweon Do	Chungcheon Bug Do	Jeju
Barley	196,456	229,330	224,216	158,711	189,150	145,318
Wheat	121,031	113,175	108,038	89,003	107,132	41,263
Soybeans	101,804	132,405	111,801	132,405	138,526	--
White Potatoes	240,030	--	13,699	18,804	14,528	--
Sweet Potatoes	-34,880	--	140,035	--	--	173,107
Millet	--	--	63,778	49,613	54,583	99,314
Corn	--	--	--	21,689	--	--
Chinese Cabbage	686,901	652,727	626,625	652,727	667,457	904,908
Radish	876,836	836,593	900,704	845,613	853,245	1,298,695
Red Pepper	6,761,185	5,790,318	5,940,646	5,571,091	6,385,365	7,982,597
Barley & Chinese Cabbage	879,227	879,564	848,161	808,872	808,872	1,026,376
Barley & Radish	1,070,854	1,057,672	1,121,885	1,002,435	1,002,435	1,420,084
Wheat & Chinese Cabbage	812,364	805,364	732,119	739,177	739,177	943,579
Wheat & Radish	992,477	947,172	983,209	932,022	957,995	1,337,288
Soybean & Radish	976,041	966,300	1,008,971	975,417	989,167	--
Apple	--	-7,272	37,640	--	-6,837	--
Peach	--	-60,926	-43,384	--	-53,950	--
Grape	721,219	361,243	351,812	--	--	966,722
Pear	--	284,068	426,259	--	--	--
Mulberry	341,478	257,416	306,584	309,757	325,617	--

1/ 1970 Prices

2/ The double crop region includes Jeolla Nam Do, Jeolla Bug Do, Gyeongsang Nam Do, and Gyeongsang Bug Do.

is apparently more than adequate for meeting initial land development requirements as well as the annual crop labor requirements. In addition, because the labor required would be used in periods of unemployment, the opportunity costs are quite low.

An estimate of the hourly labor return was made by dividing the product of the discounted net cash flow and the capital recovery factor by the hours of labor required. Under the 1969 price assumption, the hourly return ranged by province or region from 80 to 122 won per hour. The returns per hour of labor more than doubled under the 1970 price assumption. This new range was from 169 to 267 won per hour, which is still a rather low opportunity cost for labor. When the use of government subsidies was further assumed, there was a slight increase in calculated returns to required labor.

Even though the 1969 supply of farms appears adequate for a long range land development program, it would be advisable to study carefully long range rural migration expectations for the possible conclusion that in the future the current unused stock of farm labor will no longer be available. Even with adequate labor supplies, attention must be given to alternative uses of that labor and to the financial risk that must be borne by the farmer who undertakes long range land development activities. In general, the increase in hourly labor return with a subsidy program requiring nearly 52 million won was no more than the increase brought about by increasing farm prices from the 1969 to the 1970 levels.

In conclusion, we shall now enumerate a summary of the findings of the analysis. Tables 5-5, 5-6, and 5-7 show the LP solutions under the three sets of assumptions. We offer the reminder that the conclusions are based on a specific set of assumptions; and, should these assumptions be altered, then the answers would likewise be changed. To simplify the summary, we shall refer to the three sets of assumptions employed as Strategies 1, 2, and 3. Strategy 1 (See Table 5-5) will refer to the situation where 1969 farm prices (relatively low) were used, Strategy 2 (see Table 5-6) will refer to the case using 1970 prices (relatively high), and Strategy 3 (see

(Strategy 1)
Table 5-5: LP Solution for Korea (1969 Prices)

Enterprise or Activity	Utilized Land Hectares	Land Not Utilized Hectares	Discounted Total Net Cash Flow (1,000 Won)
C_1 Land	41,173	0	28,038,944
Barley	3,337		17,073
Wheat	534		56,786
Sweet Potatoes	2,726		364,057
Red Pepper	5,353		13,557,542
Barley/C. Cabbage	10,706		5,677,408
Barley/Radish	10,706		7,418,229
Wheat/Wh.Potatoes	7,811		947,849
C_2 Land	30,522	13,878	22,161,781
Grapes	4,710		2,210,588
Pears	2,737		10,997
Chinese Cabbage	5,772		1,867,661
Radish	5,772		2,705,494
Red Pepper	5,772		14,574,056
Mulberry	5,759		792,985
Total	71,695	13,878	50,200,757

Table 5-7) will refer to 1970 prices plus government assistance in the area of land development and fertility development and maintenance. The apparent conclusions are as follows:

1. The mix of crops most profitable to a region depends upon price relationships. In general, the linear programming solution specified a different set of crops for each strategy.

(Strategy 2)
Table 5-6: LP Solution for Korea (1970 Prices)

Enterprise or Activity	Utilized Land Hectares	Land Not Utilized Hectares	Discounted Total Net Cash Flow (1,000 Won)
C_1 Land	41,173	0	58,389,609.9
Barley	3,267		732,315.7
Soybenas	308		40,848.1
White Potatoes	296		71,048.9
Sweet Potatoes	10,537		1,565,703.1
Barley/C. Cabbage	10,706		9,456,881.8
Barley/Radish	10,678		12,552,634.8
Soybean/Radish	28		28,068.2
Red Pepper	5,353		33,942,109.3
C_2 Land	33,920	10,481	51,311,747.5
Apples	2,737		103,020.7
Grapes	4,710		2,309,962.3
Pears	3,398		1,354,439.8
Chinese Cabbage	5,772		3,909,154.5
Radish	5,772		5,431,077.8
Red Pepper	5,772		36,487,932.2
Mulberry	5,759		1,716,160.2
Total	75,093	10,481	109,701,357.4

2. The extent of development depends also on price relationships. Class 1 land is fully developed under each strategy. With respect to Class 2 lands, Strategy 2 develops over 3,000 hectares more than Strategy 1 and Strategy 3 develops over 8,000 hectares more than Strategy 1.

3. The amount of labor required for land development varies with price relationships and expected incomes, as

(Strategy 3)
Table 5-7: LP Solution for Korea
(1970 Prices Plus Subsidy)

Enterprise or Activity	Utilized Land Hectares	Land Not Utilized Hectares	Discounted Total Net Cash Flow (1,000 Won)
C_1 Land	41,173	0	78,447,753.5
Barley	1,005		689,875.3
Wheat	615		290,840.7
Soybeans	462		306,169.4
Sweet Potatoes	1,553		1,082,555.9
Red Pepper	5,190		12,528,743.1
Barley/C.Cabbage	10,706		20,767,595.3
Barley/Radish	10,678		29,568,898.9
Soybean/Radish	28		57,526.2
Wheat/Wh.Potatoes	10,936		13,155,548.7
C_2 Land	38,958	5,426	66,525,491.7
Apples	4,222		2,571,374.3
Peaches	3,570		1,979,674.4
Grapes	4,710		4,757,984.5
Pears	3,398		2,084,149.8
Chinese Cabbage	5,772		7,177,173.7
Radish	5,772		8,434,825.1
Red Pepper	5,772		34,753,569.8
Mulberry	5,759		4,766,740.1
Total	80,148	5,426	149,973,245.2
Government Subsidy (1,000 Won)	51,800,258		

a result of differing crop combinations specified. Average development labor requirements per hectare were 1,497 hours, 1,445 hours, and 1,484 hours per hectare for Strategies 1, 2, and 3 respectively. For all regions and for each strategy the 1969 labor supply was more than adequate for meeting initial land development labor requirements as well as the annual crop labor requirements for the crop system specified.

4. Setting upper limits for individual enterprises in keeping with the growth of individual crops through previous land development programs did not allow for complete development of Class 2 lands. The extent of Class 2 land development was 68 percent, 76 percent, and 88 percent for Strategies 1, 2, and 3 respectively.

5. A sizable increase in the total value of agricultural production would occur with an expanded upland development program. Measured in terms of the discounted total net cash flow for the three strategies, the results in Tables 5-5, 5-6, and 5-7 indicate increases of 50.2 billion, 109.7 billion, and 149.9 billion for Strategies 1, 2, and 3 respectively.

6. Despite the apparent increase in agricultural productivity, the returns to labor in this type of program are not particularly attractive. The results indicate an hourly labor return under Strategy 1 ranging from 66 to 156 won, and range from 91 to 316 won per hour under Strategy 2, and a range of from 89 to 351 won per hour under Strategy 3. 1/

One could argue that the results indicate that if the program were implemented along the lines of the linear programming solution, the situation would be an improvement over no development at all. Closer examination suggests that perhaps the relatively low returns to labor would not be attractive to farmers expected to use their surplus labor in land development activities. Although, admittedly, the calculations included an 18 percent discount rate which might be adequate for the risk involved, it is our judgement that the returns should be higher to make upland development a strong competitor for limited national resources, including human energy. One additional

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1/ This does not include any increased land equity that may have occurred as a result of the land development.

return to the owner of newly developed land which has not been considered is the discounted value of the owner's increased equity as a result of development. Presumably, most of this would be captured in the annual income generated by the new land; but when such short run fluctuations such as due to speculation create windfall gains, these gains are not accounted for in the income streams.

Contour Cultivation: A Technical Alternative?

Attention has been focused on the economic feasibility of developing uplands -- essentially bench terracing those lands with greater than five degrees of slope. This is a very costly process, both in terms of the labor requirement, and due to loss of topsoil. It is not surprising, therefore, to find that (according to the above models) within the economic limitations -- upland development is not a particularly attractive means of increasing the food supply.

There is, however, a potential technical innovation, contour cultivation, which will reduce costs and increase benefits. In a study conducted by ORD it was found that by cultivating along the contours of the uneven terrain, one avoids the problems of topsoil and mineral leaching found with traditional cultivation and substantially reduces the labor costs of bench terracing.

It was found that the "non-terracing" practice brought about lower soil erosion and a higher B/C ratio by applying the deep furrow contouring and mulching on land of slope 6-15 degrees.

Table 5-8 indicates that more labor is needed for land preparation, less area is available, and yields are lower in the case of bench terracing when compared to contour plowing.

In the previous section, the problem of farmer incentive to undertake such upland development projects was discussed. With returns so close to the margin, the question was raised as to whether a farmer would find much personal encouragement to provide the labor and capital to carry out such a project. It is, therefore, interesting to note the comparative B/C ratios for bench terracing and contour cultivation on newly developed farm land shown in Table 5-9.

Table 5-8: The Ratio of Inputs and Output Using Terracing Versus Non-terracing Methods (T/NT)

	6 Degrees	10 Degrees	15 Degrees
Labor 1/	2.5	2.7	2.8
Area	.89	.81	.71
Yields	.82	.80	.74

Source: S.K. Han, W.P. Han, K.S. Kim, and K.M. Lee, A Study on the Suitable Lower Limit of Scope in Practicing Bench Terracing, Research Report, Vol. 12 No. 6, ORD, September, 1969.

1/ Construction labor only.

Table 5-9: Benefit-Cost Ratios of Bench Terracing and Non-terracing

	6 Degrees	10 Degrees	15 Degrees
Bench Terracing	1.28	1.13	.98
Non-terracing	1.48	1.35	1.29

Source: S.K. Han, W.D. Han, K.S. Kim, and K.M. Lee, A Study on the Suitable Lower Limit of Slope in Practicing Bench Terracing, Research Report, Vol. 12, No. 6, ORD, September, 1969.

There is both a savings in cost with contour cultivation, and an increase in returns to the land. It is, therefore, quite possible that by using these figures in our own model a revised B/C ratio would now provide a sufficient margin, and therefore, incentive to the farmer. There is no question that more research should be done on this technical alternative for upland development as a means to make the price relationships more favorable.

Summary

From the above analysis we conclude that, from a purely economic point of view, it would appear that agricultural output for some time can be increased more expediently with greater attention given to the improvement of output on already developed lands, than by diverting resources to the development of new uplands.

The problem is essentially that of price relationships. Despite the 18 percent discount rate in the linear programming model, farmers will find little personal encouragement to use their own surplus labor because of its relatively low returns. There must be an adequate income farm crops grown or there will be an understandable reticence on the part of farmers to participate in land development, or possibly to continue the project once initiated.

There are ways that returns could be higher in the LP model. For example, if yields were 10 percent higher than estimated, this would make a big difference. The implication is that output increasing technological development should precede upland development. Delay, on the other hand, probably means higher labor costs since wage rates can be expected to continue to increase. In addition, despite the periodic labor surplus, Korea is in a period of such rapid off-farm migration that labor saving technological improvements should be studied. For the same reason, one should be careful about specifying labor intensive crops for the future without the provision for labor saving technology. The use of fruit crops should also be carefully considered. Besides the marginal quality of the uplands, there are other reasons why fruit crops may be undesirable: (1) the financial risk in the waiting period before maximum productivity is achieved, (2) low returns per hectare, and (3) large labor requirements. Finally, government investment in land development would be more effective if funds were concurrently allocated for roads and other infrastructure.

There may be good nonfinancial reasons for continuing upland development, such as the national goal of self-sufficiency, in which nonfinancial benefits added to the financial benefits may very well exceed costs. Little attention has been paid to the public works nature of much of the upland development. The labor used for such projects would have been either totally unemployed or underemployed; and, as a result, there is an income transfer which tends to stimulate aggregate demand with concomitant multiplier effects which stimulate national income and reduce unemployment.

Part III

AGRICULTURAL INPUT AND PRODUCT MARKETING

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Chapter 6

Policy Environment of Marketing Investments

An initial step in any study of resource allocation is an inventory of the resource environment within which those allocation decisions must be made. When choices are to be made among physical production processes, for example, the decision maker needs to know the raw materials he has available, input-output characteristics of alternative resource uses, and relevant prices or values. With this information he may rationally choose among the alternatives. The resource inventory establishes output constraints which may be modified only by application of new technologies.

For purposes of this study, resources to be allocated are investment funds from internal sources and donor agencies, time and energy of "policy implementers," and ultimately the economic resources of the country. Resource availability is a function of total population, internal economic health, and preferences of donor agencies. "Rationality" is no longer a single dimensional characteristic, but a resultant of many political, social, and economic forces. Economic feasibility data are critical in Korean investment decisions, but the policy context of those data is equally relevant. An important goal of the KASS study has been to define the physical and economic basis for development of the total agricultural sector. The introductory chapter (Part I) of this study established major economic and policy trends guiding long range public expenditure in Korea. The goal of this chapter is the more modest task of identifying the key elements of the public policy environment in Korea which will shape investments specific to the marketing system. This is not a critical analysis of market policy, but an inventory of the policy environment as it is, or seems to be.

Clearly, the policy environment in any country is not fixed. It is seldom even clearly defined. It can't be mapped, photographed, or measured like parts of a physical environment, yet the constraints it imposes are very real. The best one can do is to monitor policy trends, and attempt to gauge their impact on the options being considered. In the case of marketing system investments, certain recommendations may emerge directly from the investment analysis. But these are not politically inert; they must be evaluated in terms of the relevant parts of the policy environment.

Modes of Policy Expression

Policy is expressed in a number of ways. Some is written in formal documents or laws; some is voiced by key political spokesmen; some seems to ooze out of the system with no definable source.

The basic statement of Korean economic development policy is the Third Five Year Plan. Behind this seemingly straightforward document are written and verbal expressions of the various participants in the Korean policy process. Even for those parts relating to agricultural marketing, there are clear differences of preference or priority among several policy agents with different missions to perform. The document points directions, but choice of route varies with the participant.

Without detailed elaboration, the primary participants in policy related to marketing investment seem to be the Economic Planning Board, Ministry of Agriculture and Forestry, Ministry of Home Affairs, Ministry of Transportation, Ministry of Construction and NACF. Each has formal responsibilities related to improving the system for marketing agricultural commodities. Each also has major programs in other areas that influence their approach to solving marketing problems. Policy behavior of NACF and MAF have been explored in separate papers by the KASS team and need not be repeated here. An additional point is the emphasis on the myun level for all cooperative activities under NACF. This could influence storage location decisions. Ministry of Home Affairs has acquired major responsibility for local developments related to agricultural marketing; Ministry of Construction is responsible for the highway system for shipping farm commodities and inputs; and Ministry of Transportation is concerned with storage. In addition to differences in program emphasis, these policy participants compete among themselves for limited supplies of budget dollars.

Each of the international lender or donor agencies also has a perceived role to perform, influenced by, and in turn an influent of the key Korean policy agencies. There will be bargaining on terms and substance of individual loans between borrower and lender with resulting impact on policy.

Policy Elements

The following specific expressions of policy are relevant to alternative proposals for market system investment:

1. Food Grain Policy:

a. Grain Self-Sufficiency: For a number of reasons discussed in the Five Year Plan and KASS report, Korea is striving for grain production levels sufficient to curb imports. The 1971 imports of farm and fish commodities totaled 500 million dollars, well above the desired level. Of that amount, 297 million dollars were for food grains. Primary emphasis on domestic production may not be economically "rational" in terms of world food prices, but it achieves certain policy objectives deemed to be more important. Decreasing grain imports combined with increased domestic production with new varieties and practices affect location and type of commodity storage, pattern of commodity flow, and nature of transport facilities

b. Substitution of Barley and Wheat for Rice in the Korean Diet: Through several approaches the government has tried to influence consumers to decrease consumption of rice in favor of other grains, primarily barley. In the past, policy has been to keep rice price low and stable. The predictable result has been high quantities demanded and the need for substantial imports. With recent emphasis on achieving self-sufficiency, an active effort has been made to encourage mixing of barley with rice served in homes or restaurants. The guidelines are 20 percent barley-rice mixture for all consumption, and certain days designated "riceless" in commercial establishments. A dual price system is maintained to encourage barley production. To the extent this policy is successful, it could influence location and type of grain storage (emphasis on double-cropping region), quantities lost in drying and handling (because of labor shortage during the barley harvest-rice planting season, harvested barley does not receive as much care as harvested rice), and regional requirements for production inputs. Further, the central government has asked that farmers respond to the dual price system by providing effective on-farm storage for state-owned barley.

2. New Community Movement: Impacts of this diverse package of specific programs and less tangible policy emphases cannot be accurately defined, but they are nonetheless significant. The "movement" is at once a point of view or attitude about the impetus and process of rural development, and a series of implementing programs. 1/ Overall direction is by the Ministry of Home Affairs. It will entail redirection or reemphasis of several ongoing rural development programs identified in the Five Year Plan such as road construction, tile roofing, methane generators, etc. There is no attempt here to evaluate the movement, but only to anticipate the gross types of impacts on marketing investments.

a. Clearly, emphasis is on self-help in rural communities. Farmers are urged to acquire the new community spirit, to tighten their belts and direct some of their energy and resources toward improving the general quality of rural life. This

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1/ In the official document, New Community Movement, the effort is related to the spiritual, economic, and social environment of rural areas.

aspect of the movement is related to nearly all specific program elements. Direct government assistance will involve primarily materials and technical advice with labor provided by beneficiaries. Any investment recommendations for rural areas will likely be influenced by the self-help philosophy.

b. Model Villages: Government funds will not be uniformly distributed throughout the country, but will be directed at selected villages that show particular promise. These villages will be distributed among the provinces to provide nation wide participation. They must demonstrate aggressive leadership and popular support for the program. Government response to recommendations on market system investments will be influenced by this emphasis on intensive investment in limited areas.

c. Feeder Roads: This aspect of the farm to first receiver market component receives considerable emphasis in the new community movement. The central government will contribute approximately one-third of the cost of road construction or improvement, emphasizing the model community areas. Ongoing plans for feeder road construction by MHA may experience some redirection in response to the new community emphasis.

d. On-Farm Storage: While storage is not specifically mentioned as part of the new community program, there is emphasis on reducing product losses due to rodents. Concrete or block storage facilities can contribute much to this objective. There is also a program for providing cement for rural villages at low cost or on favorable interest terms. While concrete storage units for each farm may not be economically justified as a marketing system investment, program emphasis of the new community movement may make good quality on-farm storage more readily available to the farmer than would be true otherwise.

3. Limits on Farm Size: Following land reform in the early 1950's, farm size has been legally limited to three hectares. While exceptions to the rule are presently

allowed, this limit influences the marketing system in terms of quantity of produce any one farmer will have available for sale, his credit needs, product assembly and transport, and even the number of farm units. Recently, MAF has drafted legislation to relax this constraint for certain enterprising farmers who use new varieties or reclaim land. Further relaxation of these artificial curbs on farm size combined with expected exodus of people from the farm sector will influence government response to options for market system investment.

4. Emphasis on Improving Quality of Rural Life: Attention is focused on rural life in the Third Five Year Plan and reemphasized in the new community movement. High growth rates already have been recorded for urban economic sectors. To improve the rural-urban balance, for economic and political reasons, national resources will be directed toward the country. The self-help constraint noted above will be relevant, but emphasis on rural problems will influence official response to investment options in the marketing system. Receiving particular attention are rural roads, electrification, radio and teletype communication, medical facilities, and various measures to improve farm incomes. A recent program provides low interest loans to farmers for construction of 400,000 new farm houses. The farmer does the work and pays part of the cost.

5. Encouraged Diversity in Farm Products: To improve nutritional levels, increase food exports, reduce reliance on rice, and improve the quality and variety of food available to consumers, government policy has recently encouraged product diversity. With these changes must come better storage and transport facilities for perishable commodities, consistent and acceptable grading standards, and reliable market information.

6. Mechanization: Central government has undertaken specific programs through provincial and local governments to increase the level of farm mechanization. In 1971, 2.4 billion won of central funds were directed to provision of power tillers, sprayers, and pumps. This direct involvement in the economics of farm production will influence the marketing system and, thus, response to investment

alternatives. Power tillers, for example, are used to transport commodities and inputs to and from the farm when roads are satisfactory. They also provide power for threshing units. A related program is paddy rearrangement to permit the use of modern machinery.

7. Farm Credit Policy: The government has maintained a policy of subsidizing farm credit needs. NACF provides production and harvest credit and fertilizer loans. The terms and availability of these funds are important influents of the marketing system. Apparently, the most important factor determining time of rice or other commodity sale is the farmer's need for cash. New credit policies to relieve some of that pressure (through NACF, other agencies, or private sources) could influence the pattern of commodity flow, storage and transport needs, and use of seasonal market data. Recent government action has frozen payment on private loans to encourage use of lower interest institutional credit sources. Private rates are to be frozen at a "reasonable" level of about 25 percent with a one year grace period. While directed primarily at credit needs of urban industries, the action will affect the credit market for farmers. The immediate impact may be the drying up of credit funds as lenders turn to other investment options. 1/ Since nearly 70 percent of farm credit is from private sources, this would be significant. An exemption has been made, however, for loans less than 300,000 won, involving some 34 percent of all creditors, and practically all agricultural loans. The impact on availability of credit funds to agriculture is not at all clear. The net effect could be a small inflow of funds to farm loans.

8. Domestic Marketing System: Several stated national policies and programs are aimed directly at improving the movement of commodities from producer to consumer. MAF is constructing grain storage warehouses throughout

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1/ According to Korea Times (Seoul), land is becoming a more popular investment option following major highway construction and the August 3, 1972 credit freeze.

the country. Six farm product collection points are managed by NACF along major highways in the country. Only a portion of commodities handled by the agricultural co-operatives are assembled at these points for shipment to Seoul. Further expansion of the number and availability of government collection points could influence the pattern of product flows. Clearly, one implicit rationale for the collection system is the "demonstration effect." The collection points are highly visible evidence of attention to rural areas and participation of NACF in commodity marketing. The need for this type of collection facility at the current stage of agricultural development in Korea is a topic for debate among officials in MAF, AERI, and university economists. As another direct intervention in marketing behavior, EPB is formulating plans for market reorganization for more "orderly" flow of farm products. Included in the plan are public sale centers in cities and new wholesale markets. Implementation of a more orderly grain marketing system would significantly influence investment in storage, transport, market news, and credit.

Summary

Marketing investments will clearly be influenced by practically all aspects of public policy, since investments in one area will influence funds available for investments in other areas. No effort to tie these policy areas together has been made in this chapter. Instead, those policies or programs with most direct impact have been identified. In effect, major policy elements reveal preference weightings for different types of investments. They become part of the resource environment within which allocation decisions must be made among sectors of the economy, among investment options within the agricultural sector, and among alternatives in the marketing system.

Four major policy dimensions seem to emerge. Their effects have some commonalities, but each also constrains the others.

First, is the major attention being given by the Korean government to the process of directed economic growth. High growth rates have been achieved thus far through investments in capital intensive industry exploiting the substantial capital/labor advantages available in those industries. Investments in agriculture will likely also be in the most capital intensive areas with emphasis on increasing per capita incomes. That is, priority will likely be given to achieving economies of scale in storage, production and transportation; exploiting comparative advantages in types of farm enterprise, farm capital available, and natural resources and encouraging further substitution of capital for labor in agriculture. This approach may be contrasted to one dealing directly with various "welfare" aspects of rural life. Serious bottlenecks in the quality of life will be dealt with -- health needs, family planning, education, severe poverty -- but the long run growth strategy seems to bank heavily on the traditional process of economic growth. In terms of agricultural investments then, emphasis will be on the marketing system and, implicitly, those farmers with the economic resources to participate in it. Within marketing, needs of near subsistence farms will likely receive less priority than commercial unit needs in terms of credit needs, market information, storage facilities, etc.

Secondly, the Korean socio-policital system is a highly controlled one. Characteristics of change will be achieved with set goals redefined for provinces, gun, and villages. There will be a premium on investments such as road-side collection points, highest quality storage units, model villages. Each province also has goals for feeder road construction. Within any given gun, road location priority may well reflect economic payoff, but within the general constraint of a set goal. Investment decisions within marketing will reflect the need to maintain vertical program control through set goals at each level of government.

Thirdly, rural areas will be emphasized in national investment decisions. All information sources from official documents to popular articles suggest high priority for rural areas. In some sense, key policy makers have identified social returns from rural investments high enough to outweigh any discrepancy in monetary returns between rural and urban investment.

Finally, achieving a high degree of economic self-sufficiency is a national goal guiding investment decisions. Imports will be reduced, even at economic cost. Foreign capital will become less important over time, with strong encouragement for domestic savings and investments.

Chapter 7

Farm to First Receiver

A highly critical step in the entire marketing chain from producer to consumer involves initial product movement from the farmer. Farms are small and widely scattered. Facilities for transport and collection are often inadequate or nonexistent. The purpose of this chapter is to examine these and other bottlenecks in the early stages of product marketing, and recommend improvements. Public investment needs will receive particular attention, though private needs and institutional adjustments will also be considered.

System Characteristics

Farmers everywhere are confronted with a number of business decisions related to the various components of a marketing system. While the components themselves are not unique to Korea, their specific characteristics should be identified. Upon investigation, one is immediately struck with the complexity and diversity of the system. There appear to be no consistent, widely accepted market patterns, but an array of market channels often determined by unique local conditions. Major elements of that system are discussed here.

Product Disposal

Much of the rice produced on the 2.4 million farms in South Korea is consumed on the farm. Some is exchanged in kind for services rendered, and the rest (approximately one-third) enters commercial marketing channels. Proportions consumed on the farm vary both by province and by a size of farm as indicated in Tables 7-1 and 7-2.

On-farm consumption may take several forms, as suggested by sample observations in Kyenggi Do Province (see Table 7-3).

Table 7-1: Percent of Rice Production Consumed on Farms by Province, 1968

Province	Percent Consumed On Farm
Kyenggi Do	35.7
Chungcheon Nam Do	38.2
Chungcheon Bug Do	39.3
Jeolla Nam Do	31.9
Jeolla Bug Do	35.0
Gyeongsang Nam Do	30.8
Gyeongsang Bug Do	29.9
Ganweon Do	59.7
Average	34.8

Source: National Agricultural Cooperative Federation, International Marketing Institute, Survey of Rice Marketing in Korea, 1968, p. 50. Results are based on a sample of 300 farms throughout the country.

Table 7-2: Percent of Rice Production Consumed on Farms by Farm Size Group, 1968

Size (Ha.)	Percent Consumed On Farm
-- - .3	64.6
.3 - .7	47.0
.1 - 1.0	41.6
1.0 - 1.3	35.3
1.3 - 1.7	34.4
+ 1.7	26.7
Average	34.8

Source: Ibid, p. 51.

Table 7-3: On-Farm Consumption by Type of Consumption in Percent, 1969

Farm Use Size (Ha.)	Labor	Food For Hired Labor	Cake	Wine	Others	
-- - .5	92.3	3.0	3.1	.8	.8	(100)
.5 - 1.0	90.0	5.2	2.3	1.1	1.3	(100)
1.0 - 2.0	84.2	9.7	2.7	1.2	2.2	(100)
+ 2.0	71.1	18.8	3.7	2.5	3.9	(100)
Average	83.8	9.8	2.8	1.4	2.2	(100)

Source: Agricultural Economics Research Institute, Rice Marketing in Kyenggi Do Province, May, 1970, p. 28.

Larger farms allocate a greater proportion to consumption by hired laborers and production of rice wine.

Off-Farm Use

Of the quantity moved off the farm, some goes for in-kind payment of debts incurred, taxes due, or goods purchased while some is sold for cash. Table 7-4 indicates proportions moving off the farm for various purposes.

These percentages would also vary by size of farm, with larger farms devoting a greater proportion of rice disposal to education and acquisition of inputs, and a smaller proportion to credit payments and day to day living costs. Much of the private credit payment is for high interest in-kind rice loans by large farmers to small farmers.

Proportion moving through free market channels also varies with the transport facilities available and market proximity. Market options are varied, but practical alternatives available to the farmer are limited by various physical and economic constraints. In general,

Table 7-4: Disposal of Rice Not Consumed on the Farm In Percent, Four Villages, Kyenggi Do, 1966

Use	Percent	
Sold at Free Market	37.2	
Disposal for Private Credit	12.9	
Disposal for Government Purposes	11.9	
Grain Loan		2.1
Government Purchase		1.2
Grain Fertilizer Barter		8.5
Land Tax	5.4	
Rent and Fees	7.9	
Irrigation Fees		1.1
Fees to Village Officer		.5
Rent		6.3
Exchange for Goods and Services	15.3	
Exchange for Goods		2.9
Wages Paid in Rice		2.2
Board to Hired Labor		6.7
Polishing Fees		3.5
Miscellaneous Disposals	9.2	
Children's Schooling		3.9
Gift for Marriage or Funeral		.1
Own Marriage or Funeral		4.4
	100.0	

Source: Ban, Sung Hwan, A Study of the Marketing of Rice, Department of Agricultural Economics, Seoul National University, 1967, p. 14. Data based on sample of 300 farms in four representative villages in Kyenggi Do Province.

Table 7-5: Off-Farm Disposal by Use and by Farm Size (Ha.) In Percent, Four Villages, Kyenggi Do, 1966

Use	-.5	.5-1.0	1.0-1.5	1.5-2.0	+2	Ave.
Free Market	29	33	40	42	56	37
Credit	21	18	9	6	6	13
Government Operations	16	13	11	9	8	12
Land Tax	5	6	6	5	4	6
Direct Exchange for Goods and Services	11	14	15	21	13	15
Educational Expense	1	3	6	5	3	4
Own Marriage or Funeral	8	4	3	2	7	4
Other	9	9	7	10	3	9
	100	100	100	100	100	100

Source: Ban, Sung Hwan, A Study of the Marketing of Rice, Department of Agricultural Economics, Seoul National University, 1967, p. 14. Data based on sample of 300 farms in four representative villages in Kyenggi Do Province.

first sale may be to the government, to NACF through local cooperatives, to local assemblers, or directly to consumers. Relative importance of these major channels varies among the provinces and is influenced both by farm size and available market infrastructure. Government purchases for price stabilization or consumption by government (approximately 5 percent of total supply) are made through inspection offices throughout the country. Major participants in the marketing process remain unconvinced of the necessity of inspection. 1/

1/ Survey of Rice Marketing in Korea, op. cit. In most cases, inspection and subsequent grading resulted in a 50-100 won price increase per bag. More than one farmer in four saw inspection as basically unnecessary, or at least a greater cost than the added benefit received from sale of inspected rice.

The government channel is less popular than others for a number of reasons, including the necessity to deliver the rice and have it inspected. Also, until 1970, government price had been slightly below free market price during the peak supply months of November and December. At other times of the year when supply was lower and prices rose, government price compared even less favorably with the market.

A case study of the Honam producing area reported that marketing through the cooperative (NACF) channel was negligible, since services offered, promptness of payment, and price negotiations through that channel were less favorable than for other channels. 1/ Practically all rice sold to cooperatives was in-kind payment for fertilizer purchased at planting time or other previous commitments.

Private Market

Within the private market category, the farmer may sell to a rice miller, a local assembler, village retailer, wholesaler, or to a grain broker who buys, stores, and sells as an investment (see Tables 7-6 and 7-7). In a more recent nationwide sample, 10 percent of the 253 farmers sold rice on the farm, 26 percent in the farm village, 39 percent in periodic (5-day) markets, and 24 percent on the urban market. 2/ Whatever the prevailing practice in a village or area, the individual rice farmer's choice is usually constrained by some combination of marketing cost and traditional practice. In many cases,

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1/ Kim, S.H., "Effects of Farm-level Marketing and Credit Services on Commercialization of Subsistence, Agriculture in Korea," Proceedings of Inter-regional Workshop on Agricultural Marketing, Agricultural Development Council, 1969, p.163.

2/Lee, Sang Cho, "Study on Rice Producers Marketing," World Food and Agriculture, Vol.14, No. 6, June, 1972.

Table 7-6: Percent of Marketed Rice Sold to Various Buyers - First Sale, 1966

Buyer	Percentage Of Rice
Village Consumer	4.2
Larger Farmer	.3
Village Retailer	.1
Cooperatives	1.1
Peddler	1.9
Miller	.6
Local Assembler	20.6
Consigned Assembler	4.7
City Consumer	1.7
City Retailers	16.5
City Wholesaler	35.7
City Assembler	12.6
	100.0

Source: Ban, The Study of Marketing of Rice, op. cit. Based on 300 farms in farm villages in Kyenggi Do Province; not representative for whole country, but gives general indication of pattern.

for example, a single assembler may collect nearly all of the rice available for free market sale in a particular village. His corner on the market is maintained both by economics and historic practice. It is likely, though, that tradition would yield to economics if a significantly less expensive alternative were available to the farmer, or if excessive middleman profit attracted competitors Choice among market channels is greater for fruits and vegetables. 1/ In general, the farmer would prefer to

1/ Kim, S.H., "Effects of Farm Level Marketing & Credit Services on Commercialization of Subsistence Agriculture in Korea," Proceedings of Inter-regional Workshop on Agriculture Marketing, Joint Commission on Rural Reconstruction, 1969, p.157.

Table 7-7: Farm Sales of Rice by Type of Merchant by Province in Percent, 1968

Province	Retailer	Peddler	Miller	Assembler	Wholesaler	Other
Kyenggi Do	3.2	36.1	--	46.6	11.9	2.2
Chungcheon Nam Do	--	13.0	54.6	31.9	--	.5
Chungcheon Bug Do	3.4	81.8	11.4	3.4	--	--
Gyeongsang Nam Do	32.7	--	20.9	34.1	12.3	--
Gyeongsang Bug Do	9.3	6.4	55.3	1.5	17.2	10.3
Ganweon Do	46.5	--	--	53.5	--	--

Source: NACF, Survey of Rice Marketing in Korea, p. 59.

sell directly to a city consumer if transport and other facilities would permit that choice.

For fruits and vegetables, prices may vary substantially from day to day, and price elasticity is high. Many farmers will market their own commodities to take advantage of these changes. In addition, there is substantial return to farm level storage of perishable fruits for those farmers who can afford it. 1/

The primary criterion in the farmers' selection of first sale channel is the promptness of payment. Rural assemblers and millers offer this advantage of immediate sale even if the price they offer is lower than the prevailing consumer price. As evident from Table 7-8, one farmer in five in the Honam sample had committed sale of his crop before harvest.

1/ A fruit farmer in Naju Gun, Jeolla Nam Do Province, reported that price he receives for pears increases from 180 won per kwan to 500 won per kwan during the year, a substantial return for his farm storage unit. Personal interview, August 2, 1972.

Table 7-8: Reasons for Choice of Sale Channel *

Reason	Percent of Farmers Mentioning
Prior Commitment	19
Immediate Cash	81
Traditional Tie	19
Competition All Alike	34
No Choice	9
Good Price Offered	74
Convenience	53

Source: Kim, S.H., "Effects of Farm Level Marketing & Credit services on Commercialization of Subsistence Agriculture in Korea," Proceedings of Inter-regional Workshop on Agriculture Marketing, Joint Commission on Rural Reconstruction, 1969, p.157

* Farmers may mention more than one channel. Percentages are frequency/sample size.

Price Response

Few individual farmers have the opportunity to market commodities in response to seasonal price fluctuations. There are many reasons for this. Cash needs are immediate, and supply of saleable commodity limited. Sale is often arranged before the crop is harvested to meet previous debt commitments. Storage and transport facilities are often inadequate for effective response to price change. Further, market information is often incomplete or very costly for the individual farmer. Most of the rice is sold in units of less than 1 bag (80-84 kg.) in size. Of the rice marketed in a year, over half is sold in the November-January period when supply is greatest and price is lowest.

In many cases, farmers are aware of prevailing prices, but are unable to respond to price changes. 1/ As indicated in Table 7-9, over half the farmers in a national sample reported knowing the price of rice; only 7 percent reported not knowing the price, and the rest were only partly informed.

Table 7-9: Price Information Before Sale
(Percent of Farmers)

Province	Know	Don't Know	Know
Kyenggi Do	47.5	2.5	50.0
Chungcheon Nam Do	69.2	7.7	23.1
Chungcheon Bug Do	70.0	20.0	10.0
Jeolla Nam Do	30.0	12.5	57.5
Jeolla Bug Do	68.9	4.9	26.2
Gyeongsang Nam Do	62.5	5.0	32.5
Gyeongsang Bug Do	52.5	5.0	42.5
Ganweon	60.0	10.0	30.0
Average	57.3	7.3	35.4

Source: National Agricultural Cooperative Federation, International Marketing Institute, Survey of Rice Marketing in Korea, 1968, p. 73.

Of farms more than 8 km. away from a market, 41.7 percent reported knowing the price, while 70 percent of those less than 2 km. away were so informed. The most frequent sources of market information cited were neighbors and the marketing source itself. Mass media (radio, magazines, newspapers) were the primary sources of information for fewer

1/ In a recent survey, 80 percent of farmers across the country reported selling regardless of the price. NACF, International Marketing Institute, Survey of Rice Marketing in Korea, 1968, p. 76.

than 20 percent of the farmers. A more recent survey reported that 86 percent of farmers were aware of price before sale. In any event, most farmers feel that they are informed. 1/

Table 7-10 summarizes reasons given by farmers for their inability to take advantage of price fluctuations.

Inadequate cash for immediate consumption needs or production credit, and the small marketable supply available on any one farm are clearly the most prominent constraints on the farmer's ability to effectively use market information. Availability of on-farm storage was listed by relatively few farmers, with the greater constraint on the larger farms. Comparable, though more striking, results were obtained in the Korea Grain Association Survey (see Table 7-11). 2/

On-Farm Storage

On the average, Korean farmers produce approximately 20 bags of polished rice per year. All of this production must be stored for some period of time on the farm before being consumed, sold in-kind for services or payment of debt, or sold for cash on the open market. Clearly, the volume and seasonal fluctuation of stored supply differ among regions of the country and sizes of farm. Even farmers who sell to middlemen immediately after harvest, or store saleable produce in a nearby storage facility, must store a certain quantity for home use.

There are several alternative modes of on-farm storage. The type selected depends on costs, anticipated storage losses, length of storage time, market channel to be used, and quantity to be stored. Immediately after harvest, unhulled rice or barley is usually stored in bulk in outdoor covered straw bins. Larger, more prosperous farmers

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1/ Lee, Sang Cho, "Study on Rice Producers Marketing," World Food and Agriculture, Vol. 14, No.6, June, 1972.

2/ Ibid.

Table 7-10: Reasons for Not Responding to Price Information by Farm Size, in Percent of Farmers

Farm	Require Cash For Immediate Needs	Shortage Of Supply	Lack Of Storage	Cash For Investment	Other
-- - .3	53.5	29.0	4.0	8.5	5.0
.3 - .7	48.7	36.9	2.4	7.0	5.0
.7 - 1.0	49.7	30.0	5.2	10.3	4.8
1.0 - 1.3	49.7	31.4	4.2	10.3	4.4
1.3 - 1.7	51.5	31.9	5.4	10.3	1.8
+ 1.7	48.4	24.2	7.5	13.2	6.7
Average	49.8	30.9	4.7	10.0	4.6

Source: Lee, Sang Cho, "Study on Rice Producers Marketing," World Food and Agriculture, Vol.14, No.6, June 1972, p.77.

Table 7-11 Reasons for Sale at Low Price

Reason	Number of Farmers	Percent
No Storage Facility	1	.4
Need Cash	239	94.
Advance Sale	13	5.1
	253	100.0

may construct concrete storage houses for bulk storage. The farmer draws on his stored supply for use and for sale (see Table 7-12).

The farmer planning on early sale may mill the rice shortly after harvest and store on the farm as bagged polished rice. In that form it is ready for movement to retail channels. He may also sell or consign his rice at the local mill with storage at that facility. For longer term on-farm storage, the farmer will usually store as unhulled rice in bags. He may sell in that form or mill each bag prior to sale. Milled rice is more susceptible to damage by weevils, rodents, and spoilage, though more saleable and requires less storage space. The farm family may keep one or two bags of milled rice on hand for home consumption. The milling or polishing fee is usually about 4 percent (in-kind or cash) for rice and 10 percent for barley.

Use of alternative storage containers by size of farm is suggested in Table 7-13.

Larger farms are more likely to have a separate storage room and make less use of straw bags. A small straw drum is also relatively popular on the larger farms.

Most farm families will store several bags of rice and barley within the living area of the house. Amount stored depends on family size and alternative storage facilities. 1/ Place of storage on sample farms in Kyenggi Do is indicated in Table 7-14.

1/ Urban families also store one-half bag to 1 bag for home use, sufficient supply for approximately 3 weeks consumption.

Table 7-12: Farm Storage of Unhulled and Polished Rice by Season, October, 1970 - September, 1971, by Farm Size in Percent of Total Rice Stored on Farms

Farm Size (Ha.)	Oct. '70 - Jan. '71		Feb. '71 - Apr. '71		May '71 - Sept. '71	
	Unhulled Rice	Polished Rice	Unhulled Rice	Polished Rice	Unhulled Rice	Polished Rice
Less Than 0.5	71	29	97	3	--	--
0.5 - 1.0	74	26	92	8	--	--
1.0 - 1.5	87	13	94	6	89	11
1.5 - 2.0	76	24	75	25	99	1
More Than 2.0	83	17	92	8	93	7
Average	78	22	90	10	94	6

Source: Agricultural Economics Research Institute, "A Study of Marketing Structure for Rice in Honam Areas," Seoul, 1971.

Table 7-13: Percent of Rice Stored by Type of Container by Farm Size

Farm Size (Ha.)	Straw Bag	Metal Drum	Porcelain Jar	Wooden Box	Straw Drum	Storage Room
	Containers					
-- - .3	66.5	2.8	11.3	5.7	3.8	1.9
.3 - .7	54.0	6.2	9.6	7.3	6.1	12.5
.7 - 1.0	44.2	3.1	4.9	9.9	5.1	22.8
1.0 - 1.3	33.6	1.4	2.8	7.8	10.3	43.2
1.3 - 1.7	44.7	1.8	3.9	2.6	16.0	28.4
+ 1.7	29.1	1.1	2.1	4.5	22.3	37.2
Average	37.7	2.1	3.8	5.8	14.6	32.9

Source: National Agricultural Cooperative Federation, International Marketing Institute, <u>Survey of Rice Marketing in Korea</u>, Korea, 1968.

Table 7-15: On-Farm Place of Rice Storage
In Percent of Total Rice Stored On Farms 1/

Place	Percentage
Main Bed Room	20.3
Bed Room	26.6
Living Room	17.8
Stock Room	22.8
Warehouse	6.5
Others	6.0

1/ Ban Sung Hwan, A Study of the Marketing of Rice, Department of Agricultural Economics, Seoul National University, Seoul, 1967.

Many farmers apparently prefer to store rice in their own home rather than at a ri or gun cooperative warehouse to provide direct and personal physical security for their source of livelihood.

Product Losses

As noted, one consideration in selection of on-farm storage mode is anticipated grain loss. Loss can occur at several points between harvest and first sale. On-farm storage losses have been estimated at 13 percent of total product, with 11.5 percent by rodents, 1 percent by insects, and .5 percent from spoilage. 1/ An additional 10 percent product loss is attributed to the marketing system after initial disposal, for a total loss of 23 percent. For an annual domestic output of approximately 4.8 million

1/ Kansas State Department of Grain Science, Review of Grain Storage, Handling, Processing and Distribution Problems in the Republic of Korea, September, 1968, p. 48.

Table 7-15: Losses of Polished Rice by Storage Mode (6 Months) In Percent

Storage Mode	Percentages
Straw Bag	4.04
Jute Bag	5.0
Paper Container	4.16
Wooden Box	6.06
Metal Drum	10.32
Porcelain Jar	10.87

Source: Data supplied by Agricultural Products Utilization Research Institute, MAF, 1971.

Transportation

The final component of the farm to first sale segment of the marketing system is concerned with transporting the product to point of sale. The farmer may transport the product himself or sell to an assembler who visits his farm. Both the transport vehicle and the road conditions are important. Either or both may limit the ability of the farmer to respond to market conditions.

The mode of transport varies with the volume of product being marketed. Subsistence farmers, dealing in units of less than 1 bag for each sale to meet immediate cash needs deal primarily with peddlers and collectors. 1/ The dealer has the transport problem in these cases. Sales of this type have been most common in provinces with low total output and scattered producing units. Data in Table 7-16 indicate modes of transportation based on the 1967 rice crop. There have certainly been shifts in recent

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1/ Sample data indicate 40.5 percent of farm sales less than one bag went to peddlers, 46.1 percent went to collectors.

metric tons, on-farm losses could amount to 624,000 metric tons of rice. At 1970 prices, the value of that loss is 46.8 billion won; clearly a significant aspect of total product utilization. The estimate of on-farm losses used in the KASS simulation model is 17 percent, with another 3 percent for marketing system. The KASS estimate is based on the discrepancy between harvest and disposal, adjusted by an arbitrary production deflator.

For up to 20 days after harvest, rice may be dried in shocks in the field. The farmer moves his crop out of the field as soon as possible to limit losses. In many cases, the initial drying period may be only four or five days. Nearly all will be threshed for further drying within one month of harvest. Threshing is competitive with barley planting in the use of farm labor. Threshed rice is dried on mats to avoid mixing with stones or other debris until moisture content is lowered from about 23 percent to 16 percent. Losses to insects, birds, and rodents are particularly high during this open air drying period.

Losses during the on-farm storage period are caused mainly by rodents and spoilage. With moisture content as high as 16 percent, spoilage loss can be high during hot summer months. Reducing moisture content could reduce spoilage, but purportedly this would also decrease acceptability by consumers. 1/ Other physical loss occurs when grain is moved from the field to the storage bin, from bin to mill, and during the bagging process.

Losses recorded during a six month storage period are indicated in Table 7-15. These are experimental data and reflect the fact that long term storage of polished rice in a closed air tight container results in a high degree of spoilage. Losses to rodents or insects are not included in these figures.

1/ No research evidence is available to substantiate the consumer behavior claim. Additional consumer behavior research is indicated.

Table 7-16: Percent of Rice Transported by Transport Mode by Province, 1967 1/

Province	On the Head	A-Frame	Hand Cart	Ox Cart	Bi-cycle	Truck	Farm Gate	Total
	Mode (More Than 1 Bag)							
Kyenggi Do	.3	3.3	10.6	47.8	4.9	12.7	20.3	100
Chungcheon Nam Do	1.0	4.3	3.9	90.2	.4	--	.2	100
Chungcheon Bug Do	--	1.8	--	59.7	--	--	38.5	100
Jeolla Nam Do	--	7.4	15.1	77.4	--	--	--	100
Jeolla Bug Do	.2	3.0	31.1	50.5	3.1	--	2.3	100
Gyeongsang Nam Do	.5	5.8	32.2	28.1	9.9	--	23.5	100
Gyeongsang Bug Do	--	.8	36.1	52.4	.7	--	7.7	100
Ganweon Do	--	20.6	18.6	56.9	3.9	--	--	100
Average	.3	4.0	22.0	56.8	3.0	4.4	9.5	100
	(Less Than 1 Bag)							
Kyenggi Do	7.2	6.6	6.6	12.6	19.2	--	44.8	100
Chungcheon Nam Do	73.9	4.3	--	--	--	--	21.8	100
Chungcheon Bug Do	33.9	40.3	4.8	--	--	--	21.0	100
Jeolla Nam Do	17.8	15.6	--	66.6	--	--	--	100
Jeolla Bug Do	15.4	30.8	53.8	--	--	--	--	100
Gyeongsang Nam Do	51.0	14.8	5.4	27.5	--	--	1.3	100
Gyeongsang Bug Do	10.6	--	70.6	--	--	--	11.8	100
Ganweon Do	1.1	35.7	9.5	45.2	--	--	2.5	100
Average	27.1	16.8	9.8	20.9	6.0	--	8.5	100

Source: NACF, Survey of Rice Marketing in Korea, International Marketing Institute, Korea, 1968, p. 68.

years with increasing mechanization and commercialization, though comparison with 1970 data for Kyenggi Do shows the data are reasonably accurate.

Ox carts are clearly the most common mode for transporting rice to first sale in lots larger than one bag. Comparison of farms by distance to market shows little shift in those percentages. For lots smaller than one bag, the individual's own head or A-frame was the most frequently used mode.

The 1972 survey data in Table 7-17 show the ox cart is still the most prominent transportation mode, but power tillers have gained a significant role. Farm trucks are still not a prominent mode. These observations are based on a sample with a high percentage of commercial farms. The transport pattern suggested is more advanced than is true nation-wide.

Table 7-17: Relative Importance of Various Rice Transportation Means in Percent (Sample of 253 Farmers)

Mode	Number of Farmers	Percent
Push Cart	72	28.5
Ox Cart	75	29.6
Power Tiller	68	26.9
Truck	12	4.7
Bus	2	.8
None	24	9.5
	253	100.0

Source: Lee, Sang Cho, "Study on Rice Producers Marketing,"World Food and Agriculture, Vol. 14, No.6, June, 1972.

Feeder Road

There are no detailed data on the condition of the feeder road system and its impact on the farm to first sale segment. Some evidence is available, however, providing insights on the extent of the access problem, importance of improvement, and related cost. KASS Special Report No. 2 deals with the general road situation including feeder roads. 1/ Improving that system -- paving provincial and national roads and improving the rest -- would presumably improve product mobility in the market system. Villages and farm households with adequate access showed higher levels of commercialization and use of inputs. In very remote areas, truckers often charge a higher rate per kilometer to reflect the danger or inconvenience of getting to the farmers. 2/

According to one estimate, nearly 561,000 farms -- 31 percent of the total -- are in natural villages which are not served by a road that will permit a large truck to enter. Isolated farm households are not uniformly distributed among villages of varying sizes. Road conditions to larger villages are better than those to smaller villages where traffic generated is less. Data in Table 7-18 are derived from village size distribution by province

Over half the total number of isolated farms are in the three major rice producing provinces including the Honam region. A more detailed case study of a gun in Kyenggi Do Province revealed an average 1,240 meters of access road per village in villages not accessible by truck. For the approximately 13,000 villages in that category, there would be a total of 16,120 km. of access road needing substantial improvement throughout the country. Priority will be given to villages with more than 40 households distributed among the provinces as indicated in Table 7-19.

Feeder road improvement is currently underway with most recent impetus from the New Community Movement. Each province and gun has been assigned improvement quotas.

Indicated performance figures in Table 7-20 for 1970

1/ Kim, Sang Gee, and Libby, Lawrence W., Rural Infrastructure, Korean Agricultural Sector Study Special Report No. 2, AERI-MAF and Michigan State University, 1972.

2/ Kim, Chung Ho, "Influence of Road Class and Means of Transportation on Farm Enterprise Distribution," USAID-AERI, 1970.

Table 7-18: Provincial Distribution of Inaccessible Farms

Province	Number of Natural Villages Surveyed	Average Farm Households Per Village	Total Farm Households	Number of Farms Inaccessible by Large Truck
Kyenggi Do	4,249	50	212,450	48,550
Ganweon Do	2,579	45	116,055	36,990
Chungcheon Bug Do	2,751	49	134,799	43,169
Chungcheon Nam Do	3,129	60	187,740	65,680
Jeolla Bug Do	3,717	53	197,001	66,409
Jeolla Nam Do	4,758	60	285,480	93,900
Gyeongsang Bug Do	6,619	54	357,426	108,378
Gyeongsang Nam Do	4,683	69	323,127	97,980
Total	32,485	56	1,814,078	560,956

Source: Park, J.H., "Problems and Policy Program in Agricultural Sector Third Plan Period," Unpublished Report, 1970.

Table 7-19: Number of Large Villages Without Suitable Truck Roads by Province

Province	Villages >40 Households With Poor Road
Kyenggi Do	961
Ganweon Do	312
Chungcheon Bug Do	230
Chungcheon Nam Do	937
Jeolla Bug Do	1,076
Jeolla Nam Do	1.843
Gyeongsang Bug Do	556
Gyeongsang Nam Do	1,221
	7,136

Source: OTAM-Metra International, "Agricultural Development," Regional Physical Planning, Volume 5, Seoul, Korea, June, 1971, p.238.

Table 7-20: Feeder Road Plan and Construction (1970-71)

Province	1970 Road Length (Km)	1970 Budget (000)	1971 Road Length (Km)	1971 Budget (000)
Kyenggi Do	380 (396)	44,283 (69,617)	715	92,040
Ganweon Do	311 (344)	53,212 (65,513)	611	78,440
Chungcheon Bug Do	643 (653)	63,713 (89,196)	473	79,640
Chungcheon Nam Do	1,230 (1,298)	106,306 (109,895)	1,239	157,040
Jeolla Bug Do	810 (818)	96,840 (96,840)	530	110,760
Jeolla Nam Do	1,100 (1,100)	120,276 (120,276)	1,347	171,080
Gyeongsang Bug Do	1,460 (1,496)	163,163 (163,163)	1,296	173,160
Gyeongsang Nam Do	685 (689)	78,064 (78,064)	870	139,880
Jeju	373 (373)	24,300 (24,300)	346	37,960
Total	6,992 (7,168)	750,157 (816,864)	7,427	1,040,000

Source: Ministry of Home Affairs, Rural Development Section, figures in parentheses represent performance recorded by provincial officials.

show that quotas were met or exceeded in each province with total central government costs increased accordingly. Allocation from the 1971 budget was approximately one-third higher than for 1970. If 1971 quotas are achieved with stated priorities, nearly all villages with more than 40 households will have access roads, depending on length of road for each village.

A total of 19,066 km. of feeder road are scheduled for future construction, of which 7,042 km. are from village to village. This quota is meant to complete the farm road requirements, both for new road construction and improvement.

Summary and System Bottlenecks

Performance of the entire agricultural marketing system is strongly influenced by constraints experienced in the first steps of product movement. The degree to which individual farmers are able or willing to respond to demand and price information, in large part, determines product flow and demand response characteristics identified at later stages. This observation does not suggest that marketing bottlenecks identified at later stages are less critical. In fact, if importance were measured in concentrated volume of commodity handled, other stages may have more critical needs. Primary rationale for this brief investigation of the farm to first receiver step is to help develop the context within which marketing is undertaken. Exploration of the options facing producers and factors constraining choice among those options can help guide investigation of the total system. Relieving some of the bottlenecks at this stage may have multiplier effects for later stages. Further, identifying and evaluating a package of market system improvements for the farm sector may help to focus the efforts of researchers, government agencies and donor agencies on enhancing the lives of rural people. Such a goal is basic to any rural development program.

In general, major marketing constraints or bottlenecks in the stage from farmer to first receiver appear to include the following. They are clearly interrelated.

1. Extent to which rice is a medium of exchange in the rural economy: Beyond that consumed by the farm family, rice is still the primary currency for services received, credit, wages paid, and other purposes.

2. Constant "cash" needs of farmers: Rice is delivered in-kind or exchanged for won to meet immediate farm needs. Over half the transactions are made in units of less than one bag. Rice is often held for future cash flow needs. Other sources of credit are limited or too expensive.

3. Small quantity available for sale at any particular time on any particular farm: Assembly of scattered marketings into lots large enough for economic transport can be expensive, and thus, farmers are usually limited to one or two first sale alternatives. In many cases, only one or two buyers may work a village.

4. Apparent concern for physical possession of rice, the primary source of family security: For a number of reasons, farmers are reluctant to store their rice in government or cooperative warehouses unless sale has been arranged.

5. Inadequate price information for both product and inputs: Nearly half the farmers report having no or very little market news, particularly farmers further from market. Both the information sources and delivery system need improvement.

6. High produce losses during and immediately after harvest: Unhulled rice and barley are initially dried in shocks or spread on rice mats after threshing and then stored in straw bins. Improved facilities for early drying and storage could reduce losses.

7. Shortage of secure longer term storage facilities: More adequate on-farm storage, with low product losses, would permit the farmer to more effectively respond to market conditions.

8. Poor quality roads: Commercialization by the farmer may be limited by his ability to get product out and inputs back to the farm.

9. Inadequate transportation facilities: Movement of commodity in marketable lots is constrained in part by available transport mode.

Observed bottlenecks in the farm to first receiver component of the marketing system suggest a number of changes in that first step, and more generally for the total agricultural marketing system.

In general, system needs are: (1) improved sources of and means for providing farm credit for production and capital improvement purposes, (2) more consistent and greater availability of market information for the farmer, (3) improved facilities or institutions for assembly of produce for efficient marketing, (4) improved on-farm storage and drying facilities and/or off-farm storage capacity, and (5) better product and input transport facilities.

Chapter 8

Agricultural Credit Requirements

Approximately 80 percent of the farm households in Korea purchase some type of credit during the production year. 1/ As everywhere in the world, farm families in Korea require considerable operating capital. Income is limited to a very few months of the year, and expenses occur throughout. In many instances, lack of cash locks the farmer into a cycle of debt which forecloses any marketing options he might otherwise have. He markets to pay previous debt, with price and timing out of his hands. Better credit is not the whole answer to development in Korea; rural change can only come with technological improvements, better rural infrastructure, and generally improved choices for rural people. In many cases, however, available credit can permit fuller exploitation of the choices at hand. Average indebtedness at time of peak credit need was 25,251 won in a 1968 survey. 2/ The range was from close to 100,000 won in the rice bowl provinces to about 14,000 won in areas with less commercial agriculture. Debt levels generally start increasing in spring as planting begins and reach a peak just before harvest in September. An average of 70 percent of credit is from private sources, 24 percent from NACF, and 5 percent from other government sources. 3/ Farm family living expenses absorb about 45 percent of borrowed funds, farm production and improvement another 40 percent, and the

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1/ Credit needs for the total agricultural sector are discussed in a KASS working paper by Brake, J. and Kim, Yong Jin.

2/ Kim, Sung Hoon, "The Structure and Functioning of Rural Credit in Korea," Ph.D. dissertation, University of Hawaii, 1971.

3/ NACF, Rural Credit Survey in Korea, Korea, 1965 remainder is for debt refinancing or side business. Much is for payment in-kind at harvest, particularly for small farmers working on a close cash margin.

Interest rates for borrowers vary considerably with the source of funds. Private sources are more available with fewer strings attached, but at a high cost to the borrower. Institutional sources are cheaper, but borrowers complain of insufficient funds, time consuming procedures, and frequent refusals. Average annual rates by sources identified in the Kim, S.H. survey were as found in Table 8-1.

Table 8-1: Average Annual Interest Rate by Source of Credit, 1965

Credit Source	Computed Annual Rate
Institutional Sources	18.5
Professional Money Lenders	116.4
Traders	84.5
Manufacturers	67.3
Relatives and Friends	45.6
All Sources	56.4

Source: Kim, S.H., "Structure and Functioning of Rural Credit in Korea," op. cit., p. 219

Many small loans are made at even higher rates -- 1,000 won to 5,000 won might be borrowed at 1 percent per day rates for an effective annual rate of 365 percent. Most loans are repaid within a few months, so absolute amount of interest actually paid is usually lower than suggested by the annual rate. The longest repayment period reported in the Kim study was 8.8 months for institutional sources, with 7.3 months for farmer sources, 4 months for money lenders, and 7.3 months for friends and relatives. Only about half the credit transactions recorded in this survey involved a signed agreement.

In many cases, credit repayment is made with agricultural commodities. In-kind repayment was used in 53 percent of all loan transactions in the Kim survey with a higher rate for subsistence farms. 1/ In approximately one out of three cases, price of the product is in effect set prior to harvest, with the borrower responsible for delivery. Subsistence farmers are particularly in need of this short term in-kind type of credit to provide food in the months just prior to rice harvest. These farmers also use primarily private credit sources and pay highest interest rates.

Farmers feel strongly that a better credit system is needed. In the Kim survey, only 11 percent of the farmers expressed support for the existing situation. Over half report being unable to get credit when they need it, primarily because farm size was too small. Institutional sources were most selective among borrowers, other farmers and personal sources most available.

In terms of improvements to the system, many observers agree that institutional sources at reasonable rates should replace private sources. While the evidence on this issue is not clearcut, some farmers are paying exhorbitant interest rates to private lenders. If institutional sources are to be an effective alternative, however, new procedures will be necessary.

In the past, development policy and credit policy have been separate considerations, yet the two are closely related. To make effective use of credit for development, funds should be coordinated under single control, not meted out piecemeal for specific projects from roof improvement to house construction and from machinery investments to fertilizer purchase.

NACF has argued that meeting the credit needs of all farmers is essentially impossible. 2/ Funds are limited; priorities must be set. NACF has placed increasing emphasis on farm planning as a prerequisite to credit. Those

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1/ Ibid, p. 150

2/ NACF, Rural Credit Survey in Korea, Korea, 1965.

farmers with greatest potential for expansion or improvement get priority. NACF supports a policy of directing the smallest farmers toward other sources of income, rather than trying to sustain these subsistence units with large amounts of credit. Repayment risk is certainly a valid criterion for credit allocation. These priorities should be made explicit, and other provisions made for farmers with insufficient income earning potential. As noted, credit cannot bear the entire burden for rural development in Korea.

Another needed improvement is simplification of interest rate schedules. 1/ Rates should vary with the use to be made of the funds, not the characteristics of the lender. Credit should be tied to specific farm needs for both short term and long term capital. As an agency supposedly geared to the needs of the agricultural sector, NACF should direct credit resources toward specific farm enterprises and farm sizes. Effective and consistent loan rates for government subsidized credit would do much to discipline the rest of the loan market.

Education of farmers in the wise use of credit could do much to improve returns on borrowed funds and reduce their credit costs. The ORD, through its guidance system, should instigate such an education program. Farmers should be encouraged to undertake financial planning to direct borrowed funds toward their most profitable enterprises, and obtain the best return on thin invested funds. Farmers should have information on alternative loan terms, both costs and repayment schedule. Much of this education process must involve further research on farmer credit needs and choices, which can guide both the formation of credit institutions and training of credit users.

Credit cooperatives could become a more potent participant in rural financing if they were larger and offered services sufficient to generate membership funds. For a variety of reasons including poverty, inflation, and price

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1/ Brake, J. and Kim, Yong Jin, "The Credit Delivery System In Korea," KASS Working Paper, Michigan State University, East Lansing, Michigan, 1972 uncertainties, farmers have been unable or reluctant to save, although this is changing as income increases. Credit cooperatives should continue to be consolidated at multi-village or myun level to attract a membership large enough and staff proficient enough to sustain the credit business. This would enable cooperatives to finance more from internal funds and depend less on government funds.

Improvements suggested so far are primarily institutional in character; investment opportunities by government or donor agencies would be limited. An expanded guidance activity would, however, require additional investment and would affect many areas other than credit. Discussion of overall guidance modernization is contained in the KASS main report and in KASS Special Report Number 5. A rough estimate of 3.73 billion won for cost of guidance improvement is made by KASS. 1/ An improved credit delivery system would essentially involve realignment of existing functions. There might be additional staff needed at several points, but presumably some costs would be reduced as well. The net cost of the credit delivery system alone would not be a substantial investment item. In terms of more funds available for farm credit, however, considerable investment might be needed.

In the Kim survey, 2/ 84 percent of farmers interviewed expressed a desire to have additional credit. Average expressed credit demand by farmers surveyed was 28,125 won per loan. Their greatest need was for farm operation and side business. Large farms and fruit or vegetable enterprises expressed the greatest credit needs in terms of size of each transaction. Loan size demanded in 1965 was 2.5 times the actual loan size obtained, though number of

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1/ Rossmiller, et. al., Korean Agricultural Sector Analysis and Recommendations Development Strategies, 1971-1985, AERI-MAF, Seoul, Korea and Department of Agricultural Economics, Michigan State University, East Lansing, 1972. See also: Barlowe, Haley, Kim, Ryu, and Vincent, "An Analysis of New Land Development in Korea." Special Report No.5, 1972.

2/ Kim,S.H.,"The Structure & Functioning of Rural Credit in Korea," op.cit., p.274-300.

borrowings desired throughout the year was about equal to actual performance. Average total borrowed funds desired per farm totaled 41,905 won, about 1.7 times total funds borrowed by these same farmers in that year. Large farms achieved totals closer to their desired levels than did marginal farms. From these observations, total credit need for Korean farmers has been estimated at 107.3 billion won for the survey year. Some of that is short term, some long term to achieve growth within agriculture. KASS estimates credit demands for input expenditures in 1970 (won) to increase to 118.1 billion won in 1975, and 125.5 billion won by 1980.

It appears that substantial payoffs in terms of productivity, per capita incomes, and even the quality of rural life could be attained through provision of short term credit at reasonable rates for household expenses, production and harvesting expenses , and long term credit for farm expansion and mechanization. Many bottlenecks in the marketing system may be traced directly to a lack of operating or expansion capital. Government subsidy of interest rates of certain private lenders as well as cooperatives would be reasonable development policy.

In addition, current interest subsidy programs which provide a 17 to 23 percent interest subsidy for very few and very selective loans should be re-evaluated. With less subsidy and broader distribution of funds, government might realize greater return from investment. Farmers indicated that under current economic conditions, interest rates of 2 to 3 percent per month would induce them to borrow needed short term funds and to market grain with more price response. 1/ They currently pay an average of 4 to 5 percent per month to private sources. NACF farm loans are made at .75 percent per month, a substantial subsidy. Revised interest structure based on loan purpose would provide a more reasonable rate system, more in line with farmers' willingness and ability to pay.

There is no rationale to cut off private loan funds and replace them entirely with public funds or controls. In many cases, high interest rates are willingly paid for

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1/ KASS Field Survey, August, 1972, see Appendix IV.

services rendered or risks borne. Institutional sources should simply offer the terms and services that present a reasonable alternative to private sources, and thereby improve the entire credit system. Clearly credit demands, storage behavior, and annual price patterns are closely interrelated. To the extent that government policy to stabilize annual rice price is effective, the incentive to store rice and borrow for cash needs instead of selling will be diminished, and, thus, the interest rate the producer is willing to pay will decrease. The 24 to 36 percent annual rates suggested by farmers in the KASS field survey are based on their current inflation and price expectations.

The interrelationships between credit requirements, storage behavior, and grain price policy is important enough to warrant further exploration. The specific programs and policy instrumentation used to carry out a price stabilization policy can, if properly devised, substitute for a part of the increasing need for credit funds and can also have a strong influence upon which participants in the market system will carry out the storage function. Since rice is the most important grain, the following discussion will deal exclusively with rice price stabilization policy.

Rice Price Stabilization Policy

One of the major problems facing Korean agricultural policy makers is that of seasonal price stabilization of agricultural commodities at both the producer and consumer levels. Wide seasonal price variation over the marketing year at the producer level is attributable to a number of factors including (1) farmer need for cash at harvest to meet debt obligations incurred during the previous production year, (2) high interest rates contributing to high cost of holding the agricultural commodity during the marketing period, (3) a high inflation rate, also contributing to high holding costs, (4) storage facility costs, (5) relatively high waste and spoilage losses during storage and marketing, and (6) a less than fully developed marketing system with farmers having few or no choices in marketing their products and with buyers often having monopsonistic marketing power in local markets. On the consumer side, price fluctuations result from such factors as (2), (3), (4) and (5) above, plus varying seasonal supplies and demands for certain agricultural products, and monopolistic or oligopolistic behavior in some local markets.

The ROK government has attempted, with varying degrees of success, to intervene in domestic agricultural product markets to dampen the fall of producer prices at harvest, and the rise of consumer prices later in the marketing season. Import policies on domestically deficit agricultural commodities also include a price stabilization objective. The agricultural commodities of major consequence toward which price stabilization policies are directed are the food grains -- rice and barley. Wheat requirements are met primarily through importation.

The government grain management program is carried out under the Grain Management Law and through the Grain Management Special Account (GMSA). In addition to seasonal price stabilization, the objectives of the government program include procurement for military, prison, and other government institution use, relief, seed, grain loans, and stock reserves.

Government purchases of rice for its own use have been running about 115 thousand MT per year. To the extent that the government can time and price these purchases to partially satisfy price stabilization objectives, less rice will need to be purchased by the government purely for producer price stabilization.

Two significant changes were made in the rice program for the 1972 rice year. First, no upper limit was placed on the quantity of rice which the government would purchase at the fixed government purchase price. This meant that the government purchase price acted truly as a price floor since, if the market price dropped below the government price (disregarding differential marketing costs and the price farmers were willing to pay for the cultural reluctance to deal with government), grain flows would be to the government, not to the market. The government stood ready to purchase unlimited quantities from all farmer sellers.

The second important change was in the government stock release mechanism. As consumer prices moved up during the year, so also did the government release price with a slight differential of only 100 to 200 won per bag (80 kg.). In addition, both retailers and wholesalers could purchase government rice in unlimited quantities for resale to consumers. This change avoided the former problem with the release program, whereby government released rice, at prices as much as 1,500 won per bag below market price, was diverted into regular market channels resulting in large profits to some private dealers. Both of these changes contribute to better performance of the program in accomplishing price stabilization objectives with greater administrative feasibility.

Under the KASS model Alternative IV (recommended) assumptions, Table 8-2 indicates the simulated rice production, the marketing pattern by month, and the government purchase pattern for the 1972 rice year. Government purchasing is concentrated in the first three months of the rice year -- November, December, and January, since it is during that quarter year when 51 percent of all marketing of domestically produced rice is carried out. During the simulated 1972 rice year, approximately 485,000 tons or about 30 percent of total marketings were purchased by the government. At a government purchase price of 8,750 won per 80 kg. bag (109,375 won per metric ton) the total cost of government rice purchases was 53.0 billion won.

Table 8-3 shows that by the simulated 1981 rice year, production has increased to 4,984,000 metric tons and that marketings off farms has increased to 2,882,000 metric tons, or 58 percent of total production. Assuming the same marketing pattern over the rice year as prevailed in 1971, the central part of Table 8-3 indicate the marketing flow by month. Also assuming the same proportion of total marketings purchased by the government, and the same pattern of government purchase as in 1971, a total of 876,128 metric tons would be purchased by the government in 1981. If the government support price at that time were 10,000 (1970) won per 80 kg. bag (125,000 won per metric ton), the government cost for purchase of rice in 1981 would be 109.5 billion won.

The above calculations do not account for marketing system losses, opportunity costs for holding rice, storage costs, or administrative overhead associated with program

Table 8-2: Simulated Rice Production, Marketing Pattern by Month and Government Purchases for the 1972 Rice Year, Based on KASS Model

	MT	Percentage
Production	3,979,000	100
Used on Farms	2,383,430	60
Marketings	1,595,570	40
Marketings by Month		100.0
November	252,420	15.8
December	374,001	23.4
January	188,758	11.8
February	128,283	8.0
March	128,603	8.1
April	88,873	5.6
May	86,001	5.4
June	70,363	4.4
July	50,261	3.2
August	46,910	2.9
September	61,749	3.9
October	119,348	7.5
Government Purchases From Total Sales	484,919	30.4
November	142,008	29.3
December	263,598	54.4
January	79,313	16.3
Total	484,919	100.0

Table 8-3: Simulated Rice Production, Marketing Pattern by Month, and Government Purchases for the 1981 Rice Year, Based on KASS Model

	MT	Percentage
Production	4,984,000	100
Used on Farms	2,102,000	42
Marketings	2,882,000	58
Marketings by Month		100.0
November	455,356	15.8
December	674,388	23.4
January	340,076	11.8
February	230,560	8.0
March	233,442	8.1
April	161,392	5.6
May	155,628	5.4
June	126,808	4.4
July	92,224	3.2
August	83,578	2.9
September	112,398	3.9
October	216,150	7.5
Government Purchases From Total Sales	876,128	30.4
November	256,705	29.3
December	476,614	54.4
January	142,809	16.3
Total	876,128	100.0

operation. Some of these costs have been discussed elsewhere in this report. For example, in Chapter 10 calculations indicate that on-farm storage costs including interest (25 percent per year) on investment in and depreciation (1 percent per year) of storage facilities, opportunity cost of holding rice, (at 25 percent per year interest) and inflation (at 1 percent per month) would require a producer price increase of 3.5 percent per month to encourage on-farm storage. As an independent substantiation of this estimate, the Food Management Bureau assumes a producer price rise of 3.4 percent per month necessary to cover such costs. Costs associated with high quality off-farm storage facilities (interest on investment; depreciation) are about twice those for on-farm storage, thus requiring a price rise of about 3.8 to 4.0 percent per month.

The above assumes a market interest rate for loan funds of 2 percent per month. Thus, it is clear that to provide incentive for the farmer to store rice the producer price must be allowed to rise during the market year, or compensation must be provided for the storage and holding costs by some other means, probably by government from general tax revenues. In the same way, if others in the market systems are to be induced to store, their price must rise during the year at least enough to compensate them for storage and holding costs. Government price stabilization policy must take this into account.

We have already indicated above that under the present rice price stabilization policies, the cost of government purchases of rice, and hence, the size of the revolving fund necessary to carry out the price stabilization program and government purchase for its own use is about 53.0 billion won in 1972 and is estimated to increase to about 109.5 billion won by 1981.

Government purchases of rice for its own use should be timed for maximum price stabilization impact, <u>but should not</u> be charged to the price stabilization program, since it is a necessary government expenditure for other reasons. If we assume government rice purchases for its own use to remain constant at 115 thousand tons, the cost of this rice would be 12.6 billion won in 1972 and 14.4 billion won in 1981. Thus, the revolving fund necessary for only price stabilization is about 40.4 billion won in 1972 and 95.1 billion won in 1981.

Additional components can be built into the price stabilization program to help ease the farmer's need for cash at harvest and to provide additional incentive for the farmer to store grain until needed by the market. One such component is a nonrecourse loan provision which could easily be incorporated into the existing program. Under such a provision, the farmer could receive a loan from the government against the rice he has for sale. At any time during the year the farmer would have the option of selling the grain on the market and paying off his government loan in cash or simply delivering to the government the rice against which the loan was made. A number of specific details such as storage charges or allowances, interest rates, loanable value, and government options as to quality standards and time and place of delivery would need to be specified at values to achieve desired consequences.

To determine the size of the revolving fund necessary to carry out such a program, we will first calculate the maximum size and then attempt to make more realistic assumptions to calculate an estimated size of fund. If the government were to make loans to farmers on <u>all</u> domestically produced rice flowing into marketing channels, except government purchases for its own use at 100 percent of the government support price, the loan fund level under the assumptions would need to be 161.9 billion won in 1972 and 345.9 billion won in 1981. A more realistic assumption is that loans would be made at 80 percent of the government support price and that no more than 70 percent of the rice marketed excluding government purchases for its own use would come under loan. Under this assumption, the loan fund would need to be 90.7 billion won in 1972 and 193.7 billion won in 1981. Under this approach, farmers could obtain cash to pay off operational debts incurred during the past production year and to meet current expenses without flooding the market with rice during the first three months after harvest. A greater amount of the storage burden would be assumed by farmers in on-farm storage and less rice would actually be delivered to the government than under the present program.

The nonrecourse loan is similar in concept to the old rice lien program operated in Korea between 1957 and 1962.

The program was abondoned in favor of a direct purchase program. According to Morrow and White, during its operation -- "This program was popular with both the farmers and NACF because loan repayments to NACF were satisfactory and farmers were able to maximize their income. However, in years of short crops when market forces caused sharp upward price movements farmers repaid in cash rather than grain, so the government which financed the program failed to acquire buffer stocks for price stabilization." 1/

If the reason for abandonment of the rice lien program was, in fact, because the government did not acquire enough stocks for market intervention on the consumer side, that reason no longer exists. As long as domestic production of rice falls short of consumption and imports are required, the government has at its disposal the means of market intervention through the management of rice import stocks. In addition, when the problem is viewed from the perspective of the total grain sector the government has an even greater number of management options through the domestic barley program and the wheat import program. If operation of a nonrecourse loan program decreased the actual deliveries of rice to the government to a level equal to 10 percent of marketings, excluding government purchases for its own use, the revolving fund would need to be 93.9 billion won in 1972 and 199.2 billion won in 1981.

Another approach toward providing relief to the farmer from the pressures of debt repayment directly after harvest is delay in the debt repayment schedule of institional credit over which the government has some administrative control. A 1970 NACF credit survey indicates that the average farm household borrowings were 29,508 won and that 33.7 percent of this amount or about 10,000 won per farm household was from institutional sources. 2/

1/ Morrow, Robert B. and Paul E. White, "Spring Review of Small Farmer Credit," Unpublished Draft, USAID/RDD, Seoul 1972.

2/ Brake, et. al., "The National Agricultural Cooperative Federation: An Appraisal," KASS Special Report No. 1, AERI-MAF, Seoul, Korea and Michigan State University, East Lansing, Michigan, June, 1972.

Both the amount borrowed and the institutional source proportion has increased over time and both are expected to continue increasing in the year ahead. 1/ Of the credit from institutional sources, virtually all is through NACF.

Traditionally, the NACF has required debt repayment immediately after harvest along with other farm credit sources. With approximately 2.4 million farm households and an average institutional debt of 10,000 won per household this amounts to about 24 billion won of institutional debt coming due immediately after harvest. At a rice price of 109,375 won per ton, this amounts to 219 thousand tons of rice. If the due date on the institutional credit were changed from immediately after harvest to later in the year when the market is calling for additional rice -- say the March, April, May period -- the farmer would have an incentive to store additional rice until the loans come due and the level of the price stabilization revolving fund could be lower since some rice would be stored in anticipation of price rises in excess of interest charges on NACF loans. If farmers representing 70 percent of the institutional credit outstanding took advantage of this delay in due date, rather than selling directly to the government the price stabilization fund could be reduced by 16.8 billion won (24 billion won debt x 70 percent = 16.8 billion won) in 1972.

KASS projections indicate that agricultural credit demands will increase from about 74 billion won in 1971 to about 134 billion won in 1981. If we assume that the institutional source proportion increases to 40 percent during the period, institutional credit will be supplying about 54 billion won annually by 1981. With a decrease in farm households to 1.9 million by 1981 as projected by KASS, total borrowings per household would be 70,500 won of which about 28,000 won would be from institutional sources. Under the assumed 1981 rice price of 125,000 won per ton, total

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1/ In 1968, average farm household borrowings were 25,148 won, 26.5 percent of which was from institutional sources. See Kim, Sung Hoon, "The Structure and Functioning of Rural Credit," Preliminary draft of Ph.D. dissertation to be submitted to Department of Agricultural Economics, University of Hawaii.

institutional credit would be equal in value to 432 thousand tons of rice. Under the same assumptions as above (i.e. 70 percent of the credit is deferred to delayed due date) the price stabilization fund in 1981 could be reduced by 37.8 billion won.

The argument has been made that a delay in the due date for institutional credit would simply allow farmers to consume more and that the deficit rate would become untenably high. Experience with the rice lien program and present credit programs indicate that Korean farmers are quite dependable with respect to debt repayment. NACF statistics show approximately the same deliquency rate for current agricultural loans as for their commercial loans, leading to the conclusion that farmers are at least as dependable in credit matters as their urban counterparts. Furthermore, with the numerous services provided by NACF to farmers, that agency has considerable leverage in maintaining debt repayments and conversely farmers have considerable incentive to maintain their credit standing.

The above suggested changes in the rice price stabilization policy could help ease the farmers' strong demand for cash at harvest to satisfy incurred debt. They do not address the equally fundamental problem of credit fund availability to satisfy farmer credit demand. KASS projections indicate a demand for short and intermediate term agricultural credit of 118.1 billion won in 1975, 125.5 billion won in 1980, and 169.7 billion won in 1985. A combination of institutional change, policy reorientation, program focus, and increased funding will be necessary to provide the credit volume required by Korean agriculture.

Chapter 9

Market Information System

Clearly, if farmers are to respond to price differences, they must be aware of those prices. Farmers also need frequent advice on transport, storage, and input costs to achieve commercialization. While marketing cost data may be readily available for other participants in the marketing system, farmers are usually the last to know.

As noted in the discussion of the farm to first receiver marketing segment, most farmers reported knowing the price of rice at time of sale. A recent survey discovered, however, a broad range of opinion on high price months. 1/ Most were aware that lowest prices are in November, December, and January but there was little agreement on time of high price (see Table 9-1).

Table 9-1: Farmer Survey Response to the Question- "In Which Month is the Rice Price the Highest?"

Month	Number of Farmers	Percentage
March	2	1
April	17	7
May	55	22
June	90	35
July	23	9
August	15	6
September	51	20
	253	100

Over half the respondents reported May and June, just prior to barley harvest, as high rice price months. Nationwide

1/ Lee, Sang Cho, "Study of Rice Producers Marketing," World Food and Agriculture, Vol. 14, No. 6, June, 1972 high price months for farms are August and September, just before rice harvest. The regional effect of barley harvest on rice price may be partly responsible for the dispersion of answers. Part may be due to the fact that, because of other mitigating circumstances, high price is not a critical decision factor for farmers and therefore not of great interest. But the disparity also seems to suggest a need for more accurate farm level market news. In many cases, the farmer will still not be able to take full advantage of the price differences reported. Collectors and assemblers, not farmers, may have sufficient quantities of commodity to adjust. But knowledge of prices received by assemblers and charged by competing assemblers would enable the farmer to more fully participate in commodity marketing decisions.

Components of the existing farm market information system in Korea are reported in detail in several sources. 1/ The major elements are summarized below.

NACF and MAF are the primary sources of agricultural marketing data in Korea. In addition, the Korea Chamber of Commerce collects and publishes in daily newspapers information on wholesale prices of agricultural commodities in major cities. MAF collects daily data on wholesale and retail prices of rice and barley. Wholesale data relate to 31 markets in major cities, assembling points, and special consumption areas. Weekly wholesale data are collected from an additional 33 points. Retail price information is only for the Seoul market. MAF keeps track of rice flows to Seoul and nationwide storage of government grain as part of the grain management program. These data are not circulated outside MAF.

NACF reports current prices of agricultural commodities and inputs, and makes production and consumption projections.

1/ Kim, Sung Hoon, "An Integrated Scheme for the Improvement of Agricultural Market Information Service with Special Emphasis on Grain Marketing," paper for presentation at 1971 Seminar on Price and Marketing Policy for Grains, Seoul, Korea; International Marketing Institute, USAID, Agricultural Marketing Communications, 1968

These data are primarily for internal use by NACF staff and are not widely distributed to farmers or other participants. The only NACF data receiving wide circulation are daily wholesale and retail price quotations on 40 agricultural commodities printed monthly and distributed with a two to three month time lag. Indices of commodity and input prices are also collected and printed monthly. These are too infrequent and too aggregated to be of much use to farmers.

Information Required

Data on the quality and volume of farm products moving through marketing channels, costs of production and supplies, long term market trends, recent policy developments, and retail, wholesale, and farm prices are of key interest to farmers and other participants in the marketing system. Farmers need to know prices being paid by rice buyers in alternative first sale channels. Information is also needed on the quantities of rice and other commodities held at various points in the marketing system---by dealers, millers, and in warehouses. Other data on transportation costs, market margins, interprovince movements of grain, and technical information on new inputs or commodities would be useful as well. As any agricultural marketing researcher in Korea knows, very little of this information is currently available.

Effective market news requires an acceptable system of grades and standards for agricultural commodities. Data must be uniform. A bag of polished rice, for example, weighs 79 kg. in Jeju Do and Jeolla Nam Do; 80 kg. in the Gyeongsang Nam Do and Gyeongsang Bug Do rice areas; 82 kg. in Seoul; 84 kg. in Pyeon Taek; and up to 91 kg. in Wolsung, Chungcheon Bug Do. These differences provide the basis for quantity margins for some marketing purposes, but also generate considerable confusion at other points in the marketing system. The farmer is often the loser in the weight differential, as he is paid by the middleman for less rice than he actually sells. Quoted prices have little meaning unless tied to an accepted marketing unit.

Needed Improvements

Prerequisite to an effective market information system is rapid dependable communication. Old data may be useful for time series analysis but does not facilitate price response by farmers.

Mass Media: The problem of improving Korea's communication network is relevant to many aspects of rural development. Investments which permit rural people to become informed of alternative employment options, be aware of national policy developments of many kinds, and just stay in touch with relatives or friends in other parts of the country will also provide a system for staying informed on relevant agricultural data. In addition to providing a key aspect of urban infrastructure sustaining the interrelationship among urban centers, wider distribution of radios, telephones, and television will produce a generally better informed rural populace. Most farmers (90 percent in 1968) have radios or radio speakers in their homes, many receive newspapers regularly, 2/ and television aerials may be seen sprouting from rural villages within reasonable distance of a major city having transmission facilities. As of late 1970 there were 121 television sets per 10,000 inhabitants. 3/ While few telephones are

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1/ NACF-IMI, Joint Marketing Research Group Survey of Rice Marketing in Korea, Seoul, February, 1969, p.28

2/ International Marketing Institute, USAID, Agricultural Marketing Communications, op. cit., p.32

3/ CTAM-Metra International, "Transport and Communications," Volume 9, Regional Physical Planning, Seoul.

privately owned, (176 per 10,000 inhabitants nationwide in 1970 with over half the total in Seoul alone) most ri-dong cooperatives and government offices have telephones for receipt of market data.

Contact with the three major radio networks in Seoul revealed that agricultural programs are scheduled daily. Market price data are included to the extent they are available. The KBS public broadcasting network has facilities for nationwide coverage. KBS has one hour of agricultural programs each morning from 5:00 to 6:00. Daily wholesale prices for 31 agricultural and fish commodities in Seoul are given in 4 to 5 minutes of that hour. NACF supplies the data. There are no regional or local price data transmitted.

In addition, the two major private broadcasting networks with facilities throughout the country have farm news programs. Tong A Broadcasting Company has 30 minutes, including about two minutes of Seoul wholesale prices for rice, fruits and vegetables. Data are supplied by the Seoul Guidance Office. The programs are sponsored by the Dong Bang Agricultural Chemical Company at a price of 909,550 won per month, or 1,100 won per program minute. The Mun Wha Broadcasting Company schedules 35 minutes each day, with five minutes for Seoul wholesale prices of 31 commodities using NACF data. The Han Kuk Agricultural Chemical sponsors this program at 1.1 million won per month, or 1,030 won per program minute. Most of the time is devoted to short features of interest to farmers -- techniques and timing of pesticide application, new varieties, etc.

Another important element of any communication network is a teletype system. The NACF system extends to all nine provincial NACF offices and the major marketing centers of Seoul and Pusan. As with other NACF facilities, however, its use is limited to commodities handled by NACF within the cooperative marketing channel. For relatively little cost, use of the system could be broadened to include other marketing participants.

A medium of more direct use to farmers is mass publications -- newspapers, magazines, daily or weekly bulletins, etc. A nationwide survey 1/ reported that 20 percent of farmers read a daily national newspaper, 13 percent a weekly newspaper, and 55 percent read newspapers less than once a year. Monthly magazines were fairly popular -- 39 percent reported access. But these sources do not facilitate day to day price response.

Telephones provide a useful medium for transmission of data to central compilation points, but are not feasible as a means of getting price data out to individual farmers. Private phones would permit the farmer to compare particular input costs among alternative suppliers, discuss marketing conditions with other farmers, and generally stay in touch with other individuals.

Radios are apparently the best medium for timely and inexpensive distribution of market information to farmers, with newspapers and direct mailing of bulletins next most feasible. Written data takes more time to prepare and distribute, but provides a continuous record for future reference. Newspaper publishers have not been enthusiastic about giving space for farm news, primarily because a disbursed farm populace is a less attractive readership. Provision of concise releases of price data, together with evidence of use in rural areas, could expand use of this mode of communication.

Data Collection: The next element of an improved farm level market information system is an effective collection network. As one option, the NACF reporting network which includes the five major consuming cities, provides an excellent structural base for an improved system. More reporters would be needed, recording data on commodity and input prices at the gun level in major producing areas. Emphasis would need to be placed on farm data needs to help correct an information imbalance within the agricultural sector itself. If an expanded NACF system seems most appropriate, myun cooperatives could be the key collection element for raw data on farm price, production, commodity flows, and marketing costs. If the NACF approach is to work, market data must be widely available and not selectively released to cooperators or retained in NACF

1/ IMI-USAID, Agricultural Marketing Communications, op.cit., p.56

headquarters. In practice, wide distribution of market data may be inconsistent with NACF's role as marketing agent.

If MAF assumes the expanded statistical reporting function, as recommended by KASS and by Korean economist, Kim, Sung Hoon 1/, reporters could be attached to a nation-wide MAF enumeration system. In addition, enumerators for the current statistical reporting system of MAF might add certain categories of local market data to the farm interview series conducted regularly. The interview network is of impressive dimensions, though enumerators would require special training for the market information role.

Regardless of the institutional structure selected, expanded agricultural market reporting and distribution will necessitate a training program for those communicating and those using market news. The ORD guidance system is the logical medium for this training. Initial training for reporters should be conducted at the central government level with materials and instructors provided through ORD. Follow up detailed reporting procedures specific to local or regional production and marketing characteristics should be mailed to the gun for further distribution, and presented in supplementary training sessions at that level. Training of farmers in data use must be an ongoing activity of the rural guidance system.

Investments

There is opportunity for investment by national or international agencies in each of the three major components of an expanded information system -- communication media, agricultural market data reporting, and training in collection and use. Institutional adjustments are equally important, though will not be emphasized here. An improved agricultural information system should build on existing institutions to the extent feasible, so long as the

1/ Kim, S.H., "An Integrated Scheme for the Improvement of Agricultural Markets Information Service with Special Emphasis on Grain Marketing," IMI-USAID, Agricultural Marketing Communications.

requirements of timely, accurate, widely distributed market data are not subverted by internal preferences of the collection agency.

1. Communication Media:

a. Expanded Teletype System: Of top priority for rapid transmission of regional and provincial price data is a teletype network. Construction and operating costs of the NACF system are as follows: 1/

Construction Costs per TT Unit:

Purchase Price ---------------	W 1,700,000	(new unit)
Installation Cost ------------	100,000	
	W 1,800,000	

Annual Operating Costs per Unit (excluding interest and depreciation):

Labor ----------------------	W 1,440,000
Repairs ---------------------	80,000
Materials --------------------	103,000
Rent (Circuits) --------------	334,800
	W 1,957,800

As noted, the NACF system is strictly for transmission of information internal to that organization. It is not generally available to other participants in the marketing system. To establish a comparable system, with TT units in each provincial office, each of the five major urban consumptions centers with three extra units in Seoul would cost approximately 30,600,000 won in initial cost and 34,000,000 won per year in operating expenses, based on the above data.

Gun level NACF offices have requested installation of TT units as well for transmission of data relevant to their daily operation. Provision of TT units at the gun level for transmission of agricultural marketing data would add an additional 252 million won initially and 280 million won annually. A network with that degree of nationwide coverage by 1981

1/ Data collected from NACF.

would provide a medium for introduction of more sophisticated farm data analysis systems at a later date.

b. Radios: The publicly owned broadcasting network in Korea is sufficient to provide listening access for all farm households. According to some optimistic estimates, nine out of ten households already have radios or receivers. While the actual figures may not be that high, radios are a familiar fixture in most farm homes. Increasingly, farmers are acquiring individual receiver units rather than using a central village receiver for a household speaker. An adequate battery or electric radio will cost from 5,000 to 8,000 won. At 5,000 won per unit, cost of providing radios to the 240,000 farms without them would total 1.2 billion won. Given the extent of present broadcast coverage, the many uses of a home radio, and the relatively modest per unit cost, public investment in radio sets for marketing purposes may be hard to justify. On the other hand, provision of radio at reduced prices as a rural development project could have substantial payoffs in terms of increasing general awareness among the rural populace. The major bottleneck with radios as a medium for communication of market news is not broadcasting or receiver capacity, but farm news programming and availability of useful data. As noted above, some daily broadcast time is devoted to farm information, but price data of interest to farmers is just not available. Further, many station managers do not believe that farmers need or use the data broadcasted, thus, are not enthusiastic about expanded programming. There appears to be ample program time, however, and very little rationale for use of investment funds for purchase of more time. The big need is for better market data.

c. Telephones: Privately owned phones are an extreme rarity in rural areas. The network capacity is being expanded under the Third Five Year Plan but with major emphasis on direct dialing between major urban centers. For the 1972-76 planning period, 91.4 billion won is earmarked for intra-city telephone systems and 37.9 billion won for long distance lines between urban centers. After 1976, it is anticipated that attention will be directed to rural areas. As of 1970, only 3,042 villages out of approximately 17,000 with more than 40 households had any telephones. Another 1,200 villages were provided with telephone lines in 1971 and 459 are scheduled for 1972. Emphasis will be on the larger administrative villages. In some cases, only the village offices and a few private homes will have a phone.

Costs of telephone installation for a rural village include costs of running the line from an existing telephone circuit and costs of hook up for individual homes. The Ministry of Communication assumes an average cost of 1,200,000 won for the trunk line from the nearest gun center of existing line to the village center, and 40,000 won per unit for provision of magnetic telephone service to individual homes.

Assuming approximately 12,000 villages without telephone service and an average of 50 households per village, the following investment total may be estimated:

Trunk Line Installation: W 1,200,000 X 12,000 = 14.4 (Bil. Won)

Distribution Within Village: W 40,000 X 50 X 12,000= 24.0 (Bil. Won)

Total: 38.4 (Bil. Won)

Successful telephone coverage in rural villages, however, depends on availability of the intercity long distance network programmed for 1972-76 to provide the line capacity needed for village hook up.

2. Data Reporting Network: Given the present goals of NACF as a participant in competitive marketing of farm products, relying on NACF for collection and distribution of market data to all participants does not seem reasonable. A more feasible approach is to increase the data reporting activity of MAF. This may be done by creating a market news system or building upon an existing data

collection network. A gun level government includes officials devoting attention to agricultural production within that county with ties back through the province to MAF. Further, statistics on farm households are collected through an enumeration system based in the rural village. Between the two, MAF would seem to have a substantial data collection potential. 1/ In addition, MAF should hire market news enumerators for the 30 major cities to provide data on retail commodity and input prices.

a. Enumerators -- Local Farm Data: Since 1961, the Economic Statistics Division of MAF has conducted a Farm Household Economy Survey with data collected from 1,200 sample farms in 80 enumeration districts. Daily records are kept at each farm household. In cases where the farmer is unable to keep the records, the enumerator does it.

In effect, each district is a farm village with an average of 15 farms per district per enumerator. The enumerator is often a village resident, as he must maintain daily contact with his farm households. 2/ Results are published quarterly and annually.

The Economic Statistics Division has plans to expand the size of the national sample to 2,400 farm households in 160 enumeration districts. It would seem that with appropriate adjustments in the survey procedure, the enumeration network could provide an excellent source of daily information on

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1/ Subject to the cautions expressed by Hathaway and Rossmiller with respect to separation of program administration and statistics collection. Hathaway, Dale E. and Rossmiller, G.E., "The Organization of the Ministry of Agriculture and Forestry," Unpublished KASS Report, June, 1972.

2/ Enumerators currently are government officials, paid by the central government. As such, many prefer to reside in the gun center or nearby city rather than the farm village. This reluctance to live near the sample households is viewed as a problem by program directors. They would prefer to hire temporary government help directly from the sample village. These individuals would need to be educated, able to work with the data, and still be familiar with local agriculture and farmers.

marketing conditions at the farm level. Enumerators already collect monthly data on prices paid to farmers. They could add other categories of data to further direct the efforts of the Economic Statistics Division toward the emerging problems of agricultural commodity marketing. In those cases where the enumerator is in, or close to, a 5-day market or other village marketing center, he could collect these price data as well as from his farm households. He could concentrate on prices paid by alternative first sale channels, input prices, farm to first sale costs of transport, and storage, and other data pertinent to farm operation. He could report this information to the gun headquarters daily by telephone.

Costs of activating an expanded farm data network would include salaries for the new enumerators, higher salaries for all enumerators to help increase the general level of professionalism and training for enumerators in collection and compilation of market data. Job requirements should be tightened as well to assure effective response to the expanded data requirement. Enumerators currently earn an average of about 20,000 won per month. Annual costs of upgrading that activity may be summarized as follows:

80 New Enumerators: 24,000 Won/Month (288,000 Won/yr.)
23.040 Million Won

80 Enumerators: 4,000 Won/Month Salary Increase=
3.840 Million Won

Total Increase in Annual Cost: 26.880 Million Won

As noted, the Economic Statistics Division already has plans to expand the enumeration system, so part of the cost may be absorbed by that division. Adding the market news activity, though, will require individuals with further training and will add costs to the program. The actual marginal cost at the enumerator level, then, may be only the added salary increment

(4,000 won per month for 160 enumerators = 7,680,000 won yearly) plus the added cost of training. These could be temporary or full time government employees. Enumerators currently receive annual training through ORD at Suwon. Training costs are discussed in a later section.

b. Gun Level: Prices of farm inputs and prices paid for major farm commodities in the 5-day markets could be collected and reported by county officials, with minimal added cost. The individual might be one concerned primarily with agricultural programs or with keeping statistical records. 1/ Each county should report pertinent data for every 5-day market in that county. Distribution of collected data should include administrative villages in the county through the myun office, gun offices in neighboring counties, local radio stations and newspapers, and upward to MAF for further compilation and analysis. Distribution to myun and other counties for posting at a central location in the village, and to MAF may be accomplished by mail. In addition to data collected by the gun official, compiled farm level information from local enumerators may be summarized and distributed.

Costs of the gun level activity would be only the marginal cost of an added function for a government official, plus mailing costs. An additional 4,000 won per month for salary and overhead would suffice. 2/ For the 140 counties, annual costs would total 6,720,000 won. Distribution costs would vary with the facilities available. Telephones are most expensive in terms of variable costs for long distance transmission, but would be satisfactory for local radio or newspaper.

1/ At the county level, nearly every official is concerned in some way with agriculture since that is the predominant enterprise of rural counties. Any of these would have the capability to report market information.

2/ According to AERI specialists.

If a teletype system were established at the provincial level, the gun office would transmit data to the province for forwarding to MAF in Seoul. If a gun level TT were available, transmission to other counties and to MAF would be fast and inexpensive. In lieu of a teletype system, gun level mailing cost may be estimated as follows:

10 Myun, 3 Counties, MAF = 14 Addressees per Mailing

14 X 156 (3 Mailings per Week) X 140 Counties X 10 Won Postage = 3,057,600 Won per Year

c. City: Each of the 30 large cities in the country should have a market news reporter to moniter daily retail prices of farm commodities and inputs. This individual should be a trained marketing specialist. His data distribution would be to local radio stations, newspapers, and to MAF. Initial recruitment and hiring costs are estimated at 180,000 won. Annual costs would be salary for the 30 data reporters, and daily mailing costs. At 29,000 won per month apiece for salary and overhead, monthly salary cost would be 870,000 won and annual cost 10,440,000 won. Mailing cost would be 10 won per day, 365 days, for 30 cities, 109,500 won. Total annual cost is 10,549,500 won.

d. Central Government: The Economic Statistics Division of MAF should expand the capacity of the Seoul staff to collect, summarize, and analyze data compiled through the reporting system. In addition to preparing monthly and annual reports and trend analyses, ESD should submit daily summaries of regional price data to radio stations and newspapers in Seoul. Total costs of this expansion would include salaries and overhead for 8 market specialists and 2 information specialists. Much of the overhead cost would involve receiving and compiling the data by ESD statistical clerks.

Eight analysts at 36,000 Won/Month (including overhead)= 288,000 Won/Month or 3,456,000 Won per Year.

Two Information Sepcialists at 24,000 Won/Month = 48,000 Won/Month or 576,000 Won per Year.

Total Yearly Cost = 4,032,000 Won

Additional costs would be incurred for printing and distributing periodical summaries, purchasing radio time or newspaper space, and mailing reports. Written documents should be sent to each gun office (140), gun level guidance office (140), each city (30), provincial offices (8), relevant government institutions and agencies, and be generally available on request. An estimated 3,000 copies of monthly and annual summaries would be needed. Total printing costs are estimated at 1,470,000 won. 1/ Mailing costs are as follows:

Monthly Review - 3,000 Copies X 12 Months X 15 Won Postage = 540,000 Won/Yr.

Annual Review - 3,000 Copies X 50 Won Postage = 150,000 Won/Yr.

Total = 690,000 Won/Yr.

The annual costs for operation of the above specified reporting network are detailed in Table 9-2.

3. Training Programs: If an improved market news system is to successfully influence marketing behavior of farmers and other participants, those collecting and those using the data must be adequately trained. Reporters must understand the basic relationships among demand, supply, and price. They must know the needs of market participants and be able to direct their efforts toward these needs. More specifically, they must be able to use standard reporting terminology and grades, and be able to assemble

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1/ Annual report - .7 won/page X 100 pages = 70 won X 3,000 copies. Monthly report - .7 won/page X 50 pages X 12 months X 3,000 copies.

Table 9-2: Summary of Reporting Network Annual Costs

Farm Village - Enumerators 160		(Won)
Salary Adjustment For the Larger Number		7,680,000
Gun Level - County Officials - 140 Counties		
Salary Adjustment	6,720,000	
Mailing Costs	3,057,600	9,777,600
City Level - New Employees, 30 Cities		
Salary	8,640,000	
Overhead	1,800,000	
Mailing	109,500	10,549,000
Central Government		
Salaries	3,456,000	
Overhead	576,000	
Mailing	690,000	4,722,000
Total		32,728,000

data into a useful form for mass media. Farmers must understand seasonal price fluctuations of commodities and the cost-return characteristics of alternative sale channels. KASS has recommended substantial improvements in the Rural Guidance System. These and other investments in the education of rural people could very likely have the most impressive impact on farm life, including the marketing of agricultural products.

a. Training for Reporters: As noted, enumerators for the Farm Household Survey travel to Suwon every year for training related to data collection. Personnel from the Economic Statistics Division of MAF conduct the sessions in ORD facilities. Costs are estimated by MAF as follows:

12,000 Won per Capita - Food and Lodging for 7 days 1/

2,700 Won per Capita - Materials and facility rentals 2/

14,700 Won Total Cost per Person.

Total cost for the 80 enumerators in the present system is 1,176,000 won per year. Doubling the size of that system as planned will result in an annual training cost of approximately 2.4 million won. Only a small portion of that can be assigned to the marketing aspect of data collection. Allocation of training time to market data will increase between 1972 and 1981. An arbitrary 10 percent or 240,000 won may be a reasonable cost allocation.

A similar time period for training the 30 city level reporters in Suwon would cost approximately 441,000 won. Part of the annual training could be held simultaneously with that of the enumerators. In addition, all new market reporters would need an initial introductory training session at a total cost of approximately 1,617,000 won.

Instructional materials related to record keeping procedures, monthly data summaries, announcements, and other reports related to farm production or marketing should be sent occasionally to all market system reporters to keep them current. These mailed items would add approximately 50,000 won a year. 3/

1/ Approximately 3,000 won is for public transportation to Suwon. The remaining 9,000 won is for meals, and room in private home.

2/ Paper, booklets, pencils and other materials cost about 1,560 won; 750 won for classroom and transport rental; and the remaining 400 won for a final dinner at course completion.

3/ Assuming .5 kg. of materials monthly to each county, and city office with further distribution to farm enumerators. Mailing costs 50 won/kg. X .5 kg. per month X 12 months X 170 reporters.

b. Training for Farmers: No additional investment estimate will be made for a program to improve the farmer's facility to use market data. An expanded guidance program must gear a major part of its educational activity to the marketing needs of farmers. Most of the change needed relates to program emphasis within the guidance system rather than specific investment options. If the 3.73 billion won suggested by KASS is invested to revitalize the guidance system, the institutional framework for focusing more intensively on farm level marketing problems will be available.

4. Summary of Market Information System Investments: Recognizing that initial investments in a communication system will generate social returns far beyond those related to marketing of agricultural commodities, the investment option indicated in Table 9-3 is identified as one example of several possible alternatives.

Table 9-3: Summary of Initial and Annual Costs Under A Possible Agricultural Market Information System Option

<u>Initial Costs</u>	(000 Won)
Teletype System - 5 Cities	30,600
Counties	252,000
Radios - Half Price Subsidy	600,000
Telephone System	38,400,000
Recruiting Market Reporters	180
Initial Reporter Training	1,617
	39,284,397
<u>Annual Costs</u>	
Communication Media	
Teletype System - 5 Cities	34,000
Counties	280,000
Printing	1,470
Reporting System - Local	7,680
- Gun	9,777
- City	10,549
- Central	4,722
Training	731
Total	348,924

The market news collection system incorporated into this option is specific to farm commodity and input marketing. Since the elements of the system are extremely diverse, no time horizon or discounting is used for annual costs.

A much more detailed study should be made before investment funds are committed to building an agricultural market information system. This study should assess as far as possible the extent and incidence of direct benefits of a market information system, the other uses and benefits of the hardware required to make a market information system functional, and the interrelationships between a market information system and the more general question of statistics collection and processing, economic outlook and economic analysis systems. The above analysis indicates the desirability of making a further study of this issue.

Chapter 10

Storage and Movement of Farm Commodities with Emphasis on Storage Requirements

In this chapter, the related functions of storing and transporting rice and other farm commodities from the farm to consumer are examined in some detail. Storage capacity and needs are considered at all steps in the marketing system since storage at one level may, in effect, be an alternative to storage at other levels. Investigation of agricultural demands on the transportation system and the major transportation bottlenecks is reported in the next chapter and concentrates on the farm to first receiver segment of the system.

Public and private agencies face a complex and interrelated set of choices in handling and marketing grain and pulses. As suggested earlier in this study, selection of the appropriate alternatives can be only partially determined by economic analysis. Such issues as improving living conditions and cultural opportunities in rural areas relative to urban areas and public versus private control are involved in these decisions. The analytical procedure will be to display some realistic alternatives and discuss their relative merits from both economic and noneconomic viewpoints.

According to the KASS simulation model, total production of grain and pulses in Korea is expected to increase from 6.86 million MT in 1971 to 8.85 million MT in 1981, a 20 percent rise. Sales from farmers would be expected to increase even more percentage wise due to increased commercialization of the output. Estimates are that sales would increase from 4,602,000 MT in 1971 to 9,924,000 MT in 1981, a 116 percent rise.

The increased flows into marketing channels will require expansion in facilities for transportation, storage, handling, and milling. How and where such expansion occurs will be important factors in marketing costs and in efforts to stabilize prices throughout the country.

A number of questions arise in the process of establishing some reasonable alternatives. Overall we need to know the extent of seasonal price changes allowable by the government, what private and government interest rates will be, and what rate of general price inflation to assume.

If storage facilities are to expand, should the emphasis be on more storage on farms? After all, nearly all grain and pulses produced are stored now on farms for at least a short period. Alternatively, more local village or myun warehouses could be constructed and used by farmers as well as by the government and private firms. More storage could be constructed at the gun level.

Another policy could be to ship grain and pulses from surplus producing provinces to deficit provinces immediately after harvest, concentrating new storage facilities in the distribution centers. Such a policy would facilitate some economies of scale in storing and milling functions and make possible more storage of rice in the polished form. More pressure would be placed on transportation facilities at peak times, however.

Another issue is the type of storage to build. On the farm, the choice would be between keeping more grain in the house or barn and building straw bins or concrete storages. Off the farm, the major choice is between low temperature storages and Class A storages.

This raises the question of storing drier grain versus use of more low temperature storages. Maintaining quality of grain has been established as a major problem under current storage practices. A widely held belief is that rice at 15-16 percent moisture has superior taste and cooking qualities than rice at a lower moisture content more suitable for storage. Whether to shift to drier rice or refrigerated storage depends upon the strength of the consumers preference for the higher moisture rice, and how much of a discount the lower moisture rice would receive in the market. Storage cost is less in the drier form.

If more drying is required, where would this process be undertaken and what facilities would be required? If done on the farm, this would mean more time for field drying and drying of the grain on mats after threshing. Mechanical drying is not feasible at the present time for most farmers, although some modest facilities may be justified on some farms in the coming decade. If farmers turn more to cooperative ventures at the myun level, they may find drying equipment in conjunction with storage operations to be practical in the near future.

In building Class A and/or low temperature storages, 1/ should the program be designed to shift quickly away from Class B and Class C storages or should these storages (Class B and C) be maintained and serve as depositories for peak periods and as a reserve for unexpected demands on storage facilities? It may be quite expensive to build Class A and/or low temperature storages to handle the peak loads, with average utilization of 50-60 percent for the year. The question is how long the Class B and C storages could be utilized for grain without encountering problems with quality deterioration and loss from rodents, birds, insects, etc.

The government's policy on imports will affect storage and transportation requirements. If world grain prices exhibit substantial seasonal and year to year fluctuations, ample storage facilities would provide the government with some flexibility in timing grain purchases, although involving increased storage costs. Another question is whether imports should be programmed to move into ports near major deficit areas, mainly Incheon and Pusan; or whether some allocation should be made to other ports to make use of available facilities for unloading, milling, and storage. This also would distribute employment more widely among the provinces.

The government's policy on grain stabilization will also affect the amount and location of storage facilities and transportation requirements. How much in the way of buffer stocks the government plans to store is a major factor in total storage needs. If the government's buying and selling policy restricts the seasonal rise in prices, the government will likely acquire a substantial part of the excess of farm sales over nonfarm consumption early in the season. In this case, stocks would move to off-farm positions and more total movement of the product would occur. This is because some farmers would be more

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1/ Storage types are described in the next section.

inclined to sell grain at harvest to meet cash needs, and buy grain in the market as they need it for household consumption.

With regard to transportation, should government take a more direct role in providing transport vehicles for early steps in the marketing chain? The rural feeder road system is generally believed to be inadequate. Is there sufficient economic or social rationale for extending feeder roads to all natural villages, regardless of size, to only those villages larger than 20 households, 40 households? The question of required size and condition of these roads must be addressed. Roads extending from the farm village or household out to the fields might suffice with narrower width than village to village roads. Is there any rationale for paving feeder roads? The appropriate role of public funds in feeder road construction is of interest. Current emphasis is on self-help in road building, though, at least one international agency has constructed feeder roads as part of comprehensive rural development.

These and other questions are addressed in the following sections. Conclusions are drawn at the prefeasibility study level and investment options identified.

Grain Storage -- Costs and Capacity

Facilities for off-farm storage of agricultural commodities and inputs are distributed throughout the cities and provinces. On-farm storage patterns are discussed earlier in this study. By far the greatest capacity requirements are for fertilizer and grain, primarily rice and barley. Perishable fruits -- apples, pears, and peaches -- are also stored for short periods. Warehouses are owned and managed by the national government, agricultural cooperatives at the ri-dong, myun and gun levels and by private companies. The primary owner of private facilities is the Korean Express Company, a large multifunctional transport corporation. KEC began as a warehouse firm in 1930, added a government sponsored freight forwarding function, and in 1963 incorporated as a limited stock corporation serving all aspects of rail, truck, and sea transport. Storage of agricultural commodities is a relatively minor and apparently declining part of their total business.

Distribution of grain warehouses and storage capacity by ownership appears in Table 10-1. All those listed as government warehouses are low temperature. The number in parentheses in the first column represents the number of low temperature facilities that are insulated rather than artificially cooled. In those having temperature and humidity control, temperatures are maintained at about 15°C.

None of the private or cooperative warehouses are designated as low temperature facilities, though they have varying levels of insulation. The government low temperature facilities are also the largest of the warehouses, averaging over 900 pyong 1/ in area and 5,700 metric tons of storage capacity. In the agricultural cooperatives category, over half are at the ri-dong level, 37 percent at gun level, and the rest are rented by local or gun cooperatives. In terms of storage area and capacity, however, the gun level has just over half the total, with approximately 40 percent at the ri-dong level, and the rest in rented facilities.

Warehouses in the "others" category in Table 10-1 are privately owned by individuals or groups. They average slightly larger in size than the cooperatively owned facilities and are primarily located at the village or myun level.

The pattern of ownership by number and size is as shown in Table 10-2.

Warehouse Quality

Grain warehouses have been classified by building quality into three categories excluding low temperature facilities. Type A are generally of brick construction with tile roof and concrete floors. Size limits are usually 17 bags high, with average area of 155 pyong and capacity of 621 metric tons. The doors and ventilation systems are blocked sufficiently to limit rodent damage. Type

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1/ A pyong is an area measure equal to 35.583 square feet or 3.3058 square meters.

Table 10-1: Number and Capacity of Warehouses for Grain Owner
(As of the End of March, 1972)

	Gov't			K.E.C.			Ag. Co-Op			Others			Total		
	No.	Pyong	Capacity	No.	Pyong	Capacity	No.	Pyong	Capacity	No.	Pyong	Capacity	No.	Pyong	Capacity
Seoul	(2)1/4	4,500	29,400	8	1,761	6,640	1	130	390	58	12,177	44,544	71	18,568	80,974
Pusan	(2) 4	4,000	26,000	14	4,914	19,056	1	111	388	3	412	1,442	22	9,437	47,486
Kyenggi Do	(2) 2	2,000	12,000	51	6,170	22,747	180	15,387	56,451	110	14,878	57,040	343	38,435	148,238
Ganweon Do	(1) 1	300	1,800	39	4,472	14,407	79	5,802	18,254	48	4,101	12,765	167	14,675	47,226
Chungcheon Bug Do	(1) 1	1,000	6,000	32	3,236	11,109	336	16,903	52,467	17	1,009	3,406	386	22,148	72,982
Chungcheon Nam Do	(2) 2	2,100	12,600	71	7,128	24,280	400	22,759	71,829	80	4,881	16,142	553	36,868	124,851
Jeolla Bug Do	(2) 2	1,500	9,000	26	4,452	15,911	490	29,304	91,030	22	1,147	3,570	540	36,403	119,511
Jeolla Nam Do	(3) 4	2,800	18,400	74	7,856	28,889	569	33,237	100,327	238	14,888	48,392	885	58,781	196,008
Gyeongsang Bug Do	(2) 3	3,600	23,200	70	8,398	27,807	452	27,231	86,387	267	14,114	45,466	792	53,343	182,860
Gyeongsang Nam Do	(1) 1	500	3,000	92	7,110	24,603	217	12,006	39,106	179	11,135	35,624	489	30,751	102,333
Cheju	(1) 1	300	1,800	7	510	1,785	89	3,337	10,205	--	--	--	97	4,147	13,790
		(15,000)1/													
Total	(19) 25	22,600	143,200	484	56,007	197,834	2,814	166,207	526,834	1,022	78,742	268,391	4,345	323,556	1,136,259
Average Size		904	5,728		116	409		58	186		77	262		74	261

1/ Insulated warehouses.

2/ 15,000 pyong is insulated warehouses.

Table 10-2: Warehouse Ownership by Percent of Total Number and Percent of Total Capacity, 1972

	Percent of Total Number	Percent of Total Capacity
Government	.6	12.1
K.E.C.	11.0	16.9
Agricultural Cooperatives	65.0	45.4
Others	23.4	25.6
	100.00	100.00

B are usually constructed of tin on sides and roof, with a layer of empty rice bags or burlap on the inside at ceiling level for insulation. They are less rodent proof than Type A, and temperatures vary considerably with weather changes. 1/ They are generally smaller and older than A, and were the best warehouses available several years ago. It appears that Type A warehouses have generally deteriorated to Type B over time, with few, if any, new Type B warehouses being constructed. Type C are simply those that don't meet the standards set for A or B and, in some cases, are temporary storage facilities. They are smaller in average size than either A or B, and generally inadequate for use longer than a month.

Distribution of storage type by provinces is indicated in Table 10-3.

Figures in parentheses are comparable figures for 1968. There have been net increases in each category, though the increases have not been uniformly distributed among the provinces. Increases in the number of Type A warehouses were greatest in Seoul and Kyenggi Do, with decreases in lower quality storage available in those areas. Chungcheon Nam Do Province had the greatest increase in Type B storage.

1/ Observed temperature in mid-June was 26°C in a Type B warehouse in Suwon.

Table 10:3: Number and Capacity of Warehouses for Grain by Type
(As of the End of March, 1972)

	Gov't No.	Gov't Pyong	Gov't Capacity	Type A No.	Type A Pyong	Type A Capacity	Type B No.	Type B Pyong	Type B Capacity	Type C No.	Type C Pyong	Type C Capacity	Total No.	Total Pyong	Total Capacity
Seoul	(2)	(800)		(17)1/	(2,198)		(19)	(2,198)		(34)	(4,825)			(10,191)	
	4	4,500	29,400	40	8,525	34,100	8	1,688	5,909	19	3,855	11,565	71	18,568	80,974
Pusan	(2)	(400)		(22)	(6,943)		(16)	(3,351)		(1)	(117)		(41)	(10,811)	
	4	4,000	26,000	14	4,914	19,656	4	523	1,830	-	-	-	22	9,437	47,486
Kyenggi Do	-	-		(50)	(6,054)		(133)	(13,094)		(196)	(8,886)		(319)	(28,034)	
	2	2,000	12,000	138	19,518	78,072	167	14,835	51,920	36	2,082	6,246	343	38,435	148,238
Gangweon Do	-	-		-	-	-	(50)	(6,616)		(114)	(10,106)			(16,722)	
	1	300	1,800	-	-	-	35	4,602	16,107	131	9,773	29,319	167	14,675	47,226
Chungcheon Bug Do	-			(2)	(240)		(150)	(9,626)		(84)	(2,580)		(236)	(12,446)	
	1	1,000	6,000	3	276	1,104	95	6,523	22,831	287	14,349	43,047	386	22,148	72,982
Chungcheon Nam Do	-			(8)	(1,378)		(70)	(5,464)		(8)	(352)		(86)	(7,194)	
	2	2,100	12,600	20	2,291	9,164	156	11,315	39,595	375	21,164	63,492	553	36,868	124,851
Jeolla Bug Do	-			(70)	(13,162)		(52)	(5,102)		(162)	(9,086)		(284)	(27,350)	
	2	1,500	9,000	22	3,613	14,452	42	4,379	15,326	474	25,911	80,733	540	36,403	119,511
Jeolla Nam Do	-			(38)	(4,618)		(158)	(19,528		(352)	(18,600)		(548)	(42,746)	
	4	2,800	18,400	38	5,237	20,948	107	8,833	30,927	736	41,911	125,733	885	58,781	196,008
Gyeongsang Bug Do	-	-		(64)	(7,942)			(12,162)		(205)	(9,350)		(416)	(29,454)	
	3	3,600	23,200	30	2,961	11,844	170	14,939	52,287	589	31,843	95,529	792	53,343	182,860
Gyeongsang Nam Do	-	-		(20)	(4,284)		(91)	(8,444)		(94)	(4,926)		(205)	(17,654)	
	1	500	3,000	22	3,407	13,628	155	10,346	36,211	311	16,498	49,494	489	30,751	102,333
Jeju	-	-													
	1	300	1,800	-	-	-	11	899	3,416	85	2,948	8,844	97	4,147	13,790
Total				(291)			(887)			(1,249)			(2,431)		(789,877)
	25	22,600	143,200	327	50,742	202,968	950	78,880	276,089	3,043	171,334	514,002	4,345	323,556	1,136,259
Average Size		904	5,728		155	621		83	291		56	169		74	262

1/ Figure in parentheses are comparable number for 1968, as recorded in Kansas State University _Review of Grain Storage Handling, Processing and Distribution Problems_, September, 1968

Ownership within each quality category is shown in Table 10-4. Percentages in parentheses are the distribution of storage quality within each ownership category. Clearly, the individual or small group ownership category is a significant proportion of high quality storage both in numbers and capacity. More than 60 percent in number and 40 percent in capacity of this "other" category, however, is Type C. Similarly, nearly 75 percent of storage owned by agricultural cooperatives is of low quality. Only K.E.C. has more than half its storage capacity in A and B quality warehouses. In terms of total storage, 51 percent of the warehouses and 53 percent of storage area were of C quality as of mid-1972.

Table 10-4: Ownership/Storage Quality
Percent of Warehouses

	"A"		"B"		"C"	
	By Number	By Capacity	By Number	By Capacity	By Number	By Capacity
Korean Express Company	25 (17)	35 (32)	25 (49)	30 (43)	5 (34)	8 (25)=100
Agricultural Cooperatives	30 (3)	20 (6)	50 (17)	45 (21)	73 (80)	70 (73)=100
Others	45 (14)	45 (30)	25 (23)	25 (27)	22 (63)	22 (43)=100
	100	100	100	100	100	100

Fertilizer Storage

NACF has over 3,000 warehouses specifically designated for fertilizer storage at the gun and ri-dong cooperative levels. Table 10-5 gives a further breakdown of these facilities by level of government and quality. As is crue with grain, most fertilizer storage is of poor quality -- 79 percent of warehouses and 72 percent of capacity are Type C. In general, storage quality is better at the gun level than at the village level.

Table 10-5: Fertilizer Warehouses, NACF Owned, by Number and Size

		By Number	Average Pyong
		Percent	
County Cooperatives	A	49 (9)	85
	B	221 (42)	75
	C	252 (49)	69
Total		522 (100)	
Ri-Dong Cooperatives	A	45 (3)	54
	B	326 (22)	42
	C	1116 (75)	29
Total		1497 (100)	
Rented	A	6 (3)	154
	B	40 (17)	65
	C	193 (80)	44
		239 (100)	
Totals	A	100 (3)	(75)
	B	587 (18)	(56)
	C	2561 (79)	(23)
		3248 (100)	100

Cost of Construction and Operation

Improved storage quality is certainly not without added cost, both in initial construction and annual expenses. These increased costs must be compared to additional return or reduced losses attainable from higher quality facilities in developing investment rationale.

Artificially cooled low temperature warehouses are the most elaborate and most expensive of the storage types. Initial construction costs of the six existing air-conditioned warehouses vary considerably. Average costs are 153,786 won per pyong of total area, including cost of equipment for cooling and humidity control, but excluding land cost.

At the average size of 1,600 pyong, a cooled, low temperature warehouse would cost 246,057,600 won to construct. These facilities are built in major urban centers where land costs are high--averaging close to 45,000 won per pyong. Total land required per warehouse would be about 2.5 times the storage area or 4,000 pyong, for a cost of 180 million won. Grand total per warehouse averages 426 million won -- a substantial investment.

Initial costs of insulated low temperature warehouses are considerably less, and somewhat comparable to the new Type A. Estimated construction cost is 83,000 won per pyong. For the average 500 pyong warehouse, costs would be 41.5 million won plus 60 million won for land (40,000 won/pyong) for a total of just over 100 million won.

Annual operating costs for the two types of low temperature facilities differ essentially by the cost of operating the cooling equipment. (See Table 10-6).

Table 10-6: Comparison of Annual Operating Costs of Air-Conditioned and Insulated Warehouses of the Same Size (500 Pyong)

	Air-Conditioned	Insulated
Wages	1,137,600*	1,026,000**
Overtime Allowance	289,232	289,232
Fuel for Office	101,640	101,640
Electricity	1,520,000	130,363
Telephone	52,800	52,800
Water	126,000	126,000
Insurance	515,155	321,056
Repair (Bldg.)	545,423	339,919
Repair (Machinery)	850,413	17,080
Official Goods	188,260	75,760
Total	5,326,523	2,479,850

* Operator of Machinery - 316,800 Won
Six Guards 820,800 Won

** Technician 205,200 Won
Six Guards 820,800 Won

For Type A warehouses, NACF has estimated initial construction costs for 100 pyong facility at 5,650,000 won, excluding land cost, or 56,500 won per pyong. KEC has estimated construction costs of 60,000 won per pyong. Land costs would add another 35,000 won per pyong for a total cost of 91,500-95,000 won per pyong. Operation costs for 100 pyong facility have been calculated by NACF as indicated in Table 10-7.

Table 10-7: Annual Operating Cost-
Type A Warehouse (100 Pyong)

Item	Cost (Won)
Salaries and Wages	210,000
Loading	25,968
Repair	18,600
Office Supplies	10,550
Electricity	16,301
Depreciation (50 years)	128,920
Insurance	23,482
Others	28,791
Total	412,612

Initial and annual costs for a comparable warehouse owned by K.E.C. or another private firm would total much higher than for an NACF facility. The private firm pays additional taxes and is likely to pay higher wages to employees. Other materials and costs may also be higher since smaller quantities of these items are involved.

Construction costs of on-farm storage units were estimated in farm interviews in Chungcheon Bug Do and Chungcheon Nam Do Provinces in August, 1972. Farmers reported that straw bins with capacity of 50 to 60 bags (4-4.8 metric tons) cost from 4,000 won to 4,800 won to construct. This is approximately 2,000 won per pyong of area or 1,000 won per metric ton of storage capacity. Included are labor (1 man day at 700 won) and materials (straw - 1,200 won to 1,700 won, and metal base shield - 1,600 won). Other costs add an average of 500 won to the total.

Cement or brick storage units cost an average of 14,000 won per pyong or 7,000 won per metric ton storage capacity, of which about 3,150 won is labor cost.

Storage Revenue

Charges for stored commodities (government owned) are set by MAF. Rates for 1971 and 1972 are shown in Table 10-8.

Table 10-8: Storage Charges - Grain (NACF Warehouses by Class) - 1971, 1972 (Won/Metric Ton/Day)

	1971			1972		
	A	B	C	A	B	C
Polished Rice	7.70	7.00	6.50	8.50	7.80	7.20
Barley	6.10	5.50	5.10	6.80	6.10	5.70
Unhulled Rice	6.80	6.10	5.70	7.50	6.80	6.30

In general, storage charges are meant to cover costs of storage, assuming 80 percent utilization rate. In 1971, NACF estimated a 45 percent utilization rate which would have required a charge of 13.06 won per metric ton per day to cover costs. K.E.C. argues that given current construction and operating costs, charges are too low to sustain profitable operation. Further, seasonal supply fluctuations combined with a fixed government rice price impose too great a risk on the private storage company. Costs of low temperature facilities are particularly prohibitive.

As of July 1, 1972, storage charge adjustments to privately owned commodities have been instituted by Ministry of Transportation. For rice, the rate is 7.39 won per 100 kilograms for 15 days plus .001 times current price. At 10,000 won per 100 kilograms, the new rate calculates to 11.6 won per metric ton per day -- substantially above the current government schedule. For other grains, the new rate is 12.1 won/MT/day. On July 1, 1973, the new rates will also apply to government owned commodities and fertilizer.

Product Losses in Storage

There have been various estimates of the quantity of stored grains lost to various sources. The Kansas State storage study estimated total losses from the marketing system at 10 percent, including handling, transporting, storing and retailing. 1/ Assuming a total product of 4.6 million metric tons, marketing loss would be approximately 460,000 MT. In their unpublished "International Economic Cooperation Plan for Development" of June 1972, the Economic Planning Bureau estimated the value of product lost in storage at 1.3 billion won. At 10,000 won per 80 kilogram bag, estimated loss would be 10,400 metric tons, clearly a most conservative loss estimate. The Institute of Agricultural Engineering and Utilization Research, MAF, reported losses during nine months of storage in 1970 as indicated in Table 10-9.

Table 10-9: Quantity Losses of Rice During Storage (9 Months) by Type of Warehouse, Feb.-Oct., 1970, in Percent

	Low Temp.	Type A	Type B	Type C
	Percent			
Unhulled Rice	0.96	1.30	2.24	3.28
Unpolished Rice	1.04	2.24	3.82	4.65
Polished Rice	1.55	2.48	4.46	4.90

1/ Kansas State University Department of Grain Science, Review of Grain Storage Handling, Processing, & Distribution Problems in the Republic of Korea, USAID, Seoul, Korea, September, 1968.

These loss figures exclude effects of rodents and other sources. Only the effects of spoilage and respiration are included. Polished rice is clearly the most vulnerable if stored for long periods. Type C storage is strongly affected by temperature changes, thus the loss increases from low temperature to Type C facilities. Reduction of these losses is a key rationale for storage improvement.

Storage and Transportation Requirements for Grain and Pulses by Province

Appendix I describes in detail computations of net balances between production and consumption by province. Estimates of storage and transportation requirements by province were obtained by the following procedure. Carry-over levels (off farms) for rice as of October 1, and barley as of June 1 were set equal to amounts needed to meet nonfarm consumption for two months in each province. The difference between sales from farms and urban consumption was observed for the country as a whole, which indicated October to January to be the period of net movement of rice into storage and June to September to be the period of net movement of barley into storage. The remainder of the respective crop years for rice and barley involved net outmovement. This being the case, peak storage requirements for rice would be expected around February 1 and peak requirements for barley storage would be around October 1, just prior to rice harvest. Since rice so predominates the grain picture, the peak in storage requirements for both rice and barley plus other grain and pulses would be expected around February 1.

In programming how much grain would move into storage in each province, how much grain would be shipped from surplus to deficit provinces, and from where and to where the shipments would go, a set of arbitrary but realistic rules were established. The following rules were followed as closely as possible.

1. Stocks off farm are not to drop below levels equal to a two month supply for nonfarm consumption

2. At peak levels, off-farm stocks in each province will be at least equal to available storage based on actual 1972 levels of Class A and B storage and adjusted upward for 675 warehouses (100 pyong each) under construction in 1972 and downward for depreciation at 2 percent per year.

3. Average utilization rate of storage facilities (average storage level divided by capacity) will be at least two-thirds in each province.

4. Movement of grain into deficit provinces will be from nearest surplus provinces in line with major rail and highway connections. Direction and route of movement are indicated by a linear programming transportation model computed by Otam-Metra. 1/

5. Movement of grain into deficit provinces will occur only as needed for consumption and not to build up stocks in the deficit provinces. The exception to this would be to build up stocks if unutilized capacity exists in deficit provinces during the peak in storage requirements for the nation.

6. Any import requirements will be fulfilled at the end of the crop year. Imports are to arrive two months prior to the month when they are needed. Allocation to ports will be based on port facilities and capacities and the projected capacities.

7. Any grain available for export will not be shipped until the end of the crop year when the size of the new crop can be reasonably assessed.

8. All grain is shipped in hulled form, mostly as polished grain. Storage off the farm in each province is primarily in the hulled form.

For ease of computation and presentation, the year was divided into three segments: October through January (accumulation of rice stocks), February through May, and June through September (accumulation of barley stocks). From

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1/ Otam-Metra International, Transportation and Communications, Regional Physical Planning, Vol. 9, Seoul, Korea, June, 1971.

the projections of nonfarm consumption by province for 1981, estimates were made of the minimum allowable carryover of a two month supply by dividing annual nonfarm consumption by six. These amounts were established as the carryover level for rice on October 1 and for barley on June 1. Off-farm storage levels for other grains and pulses, except wheat, were assumed to be constant year around at the two months supply level. The amount of these grains in storage is small and would have little effect on total storage requirements. Wheat was excluded from this analysis because of the special storage facilities required. Most wheat is imported and stored at mills in major ports.

Table 10-10 shows the projected stocks of grain and pulses for 1981-82 for October, February and June. Seoul is included in Kyenggi Do and Pusan in Gyeongsang Nam Do.

Carryover Levels

The projected carryover levels are less than proposed by the Third Five Year Plan for 1971-76, but larger than experienced in 1969 and 1970. The indicated levels should be sufficient to stabilize prices and provide adequate protection against unexpected crop failures. The carryover level on rice should not be considered independently from carryover levels on barley. Since the two crops are grown and harvested at different times of the year, unusual weather would not likely effect both crops to the same extent. For example, in 1960-70, the average year to year percent change up and down for rice production was 12.2 percent, and for barley 14.9 percent. For the combined production of rice and barley, the average year to year percent change was 8.7 percent. In only two cases was the percent change on the combined output greater than on rice alone.

Also to be considered in establishing minimum carryover levels for these crops is the close substitute relationship between rice and barley in food consumption. The fact that storage stocks of barley are at their peak at the end of the rice crop year reduces the carryover

Table 10-10: Projected Stocks of Grain and Pulses (Except Wheat) In Off-Farm Storage, October 1, February 1, and June 1, 1981 - 82, in 1000 M/T

Province	Rice			Barley			All Grains Excl.Wheat		
	Oct.1	Feb.1	Jun.1	Oct.1	Feb.1	Jun.1	Oct.1	Feb.1	Jun.1
	1000 M/T								
Kyenggi Do	207	259	207	67	67	54	304	356	291
Chungcheon Nam Do	24	86	80	6	6	6	34	96	90
Jeolla Bug Do	15	259	259	89	43	4	106	304	265
Jeolla Nam Do	32	179	179	269	269	8	306	453	192
Gyeongsang Bug Do	55	168	141	108	80	14	171	256	163
Gyeongsang Nam Do	94	159	94	165	154	25	272	326	132
Ganweon Do	23	36	36	10	10	6	37	50	46
Chungcheon Bug Do	5	103	103	1	1	1	7	105	105
Jeju	3	8	8	2	2	1	5	10	9
Total	458	1257	1107	717	632	119	1242	1956	1293

requirement for rice. By 1981, storage stocks of rice at the end of the barley crop year should be sufficient to act as a buffer for barley.

When crop failures do occur, the Korean government should be able to obtain needed imports well in advance of the time that domestic supplies would be exhausted. Supplies of grain in the world market in the next decade should be ample and prices should be at reasonable levels. As reported in Korean Agricultural Sector Analysis and Recommended Development Strategies, world rice prices are expected to be stable during the 1970's. 1/ The Korean government might well rely on imports to supplement domestic supplies rather than incurring the high cost of storing the additional grain needed for any conceivable emergency. Total crop failures seldom occur. From 1960 to 1970, the largest year to year percentage drop in the combined production of rice and barley was 12 percent between 1960 and 1961. Future developments in land and water use and other cultural practices may reduce annual production variations. The argument for stockpiling grain for a national emergency seems less convincing today than two or three years ago.

To consider alternative carryover levels, the storage data in Table 10-10 would be changed in direct relationship to the change in beginning stocks.

Anticipated Storage Facilities

In order to program movement into storage for 1981-82 some appraisal was needed of prospective storage facilities in each province not including any additional storages that might be constructed. Such estimates are, of course, necessary in order to establish additional storage requirements. At this stage in the analysis, the estimates were used to determine the minimal amounts stored in each province at the peak season. This was to make sure that all available storage would be utilized.

1/ Rossmiller, et. al., Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, Agricultural Economics Research Institute, MAF, Seoul Korea and Department of Agricultural Economics, MSU, East Lansing, 1972, p.132.

In the grain deficit provinces of Kyenggi Do, Ganweon Do, and Jeju, the original intent was to keep storage levels equal to a two-months urban supply throughout the year. This would keep as much grain as possible in the production areas until needed. However, when this procedure was followed for the anticipated supplies in 1981, prospective storages in these three provinces were not fully utilized in the peak storage season. Therefore, storage levels were programmed to fill these facilities in the subsequent analysis.

Rate of Utilization

As indicated in Table 10-11, the average rate of utilization of storage capacity would be around 77 percent for the nation as a whole in 1981, ranging between 67 percent in Chungcheon Nam Do to 89 percent in Kyenggi Do.

Table 10-11: Rate of Utilization of Storage Capacity Assuming Storage Capacity is Equal to Peak Monthly Inventories, 1981

Province	Average Monthly Stocks for the Year	February Stocks	Average As a Percent of February Stocks
	1,000 MT	1,000 MT	Percent
Kyenggi Do	316	356	89.0
Chungcheon Nam Do	73	109 1/	67.0
Jeolla Bug Do	235	304	77.3
Jeolla Nam Do	327	453	72.2
Gyeongsang Bug Do	199	256	77.7
Gyeongsang Nam Do	253	326	77.6
Ganweon Do	44	50	88.0
Chungcheon Bug Do	71	105	67.6
Jeju	8	10	80.0
Total	1526	1969	77.5

1/ April 1.

This assumes that the capacity in each province would be equal to the peak in storage stocks. The peak was reached in February except in Chungcheon Nam Do where stocks continued to accumulate until April 1. This rate of utilization is higher than has been experienced. Based on estimate for 1972, using total Class A and B storage plus new small warehouses constructed in that year, peak storage levels on February 1 were at only 80 percent of capacity. (See Tables 10-15 and 10-16)

Movement of Rice and Barley

The movement of grain within Korea needed to achieve the indicated storage pattern is presented in Tables 10-12 and 10-13. For convenience, provinces will be abbreviated as follows: Kyenggi Do (Ky), Chungcheon Nam Do (CN), Jeolla Bug Do (JB), Jeolla Nam Do, (JN), Gyeongsang Bug Do (GB), Gyeongsang Nam Do (GN), Ganweon Do (Ga), Chungcheon Bug Do (CB), and Jeju, (Je). The city of Seoul is included in Kyenggi Do and Pusan is included in Gyeongsang Nam Do. These tables show the origin and destination of rice and barley shipments by four month periods. The origin is represented by the rows in the matrices and the destination by the columns. The amounts shown under "Total" in the right hand column represent the difference between farm sales and nonfarm consumption in each province. The row labeled "Total" at the bottom of each matrix is the addition (or subtraction) to inventories in each province. The numbers in the matrices stated in terms of 1,000 MT of polished grain represent the effect of the movement of grain from the origination province to the deficit province. The numbers on the diagonal represent the change in supplies within a given province coming from indigenous supplies.

For example, in Table 10-12, the -137 in October-January for Kyenggi Do Province as the origin and the destination means that a deficit of 137,000 MT in that province developed as sales from farm fell that far short of nonfarm consumption. This deficit was filled by shipments of 189,000 MT from Chungcheon Nam Do which also resulted in a buildup of 52,000 MT in storage stocks in

Table 10-12: Movement of Rice From Provinces of Origin To Provinces of Destination, and Changes in Storage Stocks by Province, Projected to 1981-82

Destination / Origin	Ky	CN	JB	JN	GB	GN	Ga	CB	Je	Residual	Total
October to January											
Ky	-137										-137
CN	189	62									251
JB			244								244
JN				147					22		169
GB					113		46				159
GN						65					65
Ga							-33				- 33
CB								98			98
Je									-17		- 17
Tot	52	62	244	147	113	65	13	98	5		799
February to May											
Ky	-286										-286
CN	97	-6									91
JB	96		0								96
JN				0		22			22		44
GB					-27	2	40				15
GN						-89					- 89
Ga							-40				- 40
CB	41							0			41
Je									-22		- 22
Tot	-52	-6	0	0	-27	-65	0	0	0		-150
June to September											
Ky	-346										-346
CN	82	-56									26
JB	184		-244			67				31	38
JN				-147		68			12	61	- 6
GB					-86	12	30				- 44
GN						-135					-135
Ga							-43				- 43
CB	80							-98		35	17
Je									-16		- 16
Tot	0	-56	-244	-147	-86	12	-13	-98	- 5	127	-509

Table 10-13: Movement of Barley From Provinces of Origin to Province of Destination, and Changes in Storage Stocks by Province, Projected to 1981-82

June to September

Origin \ Destination	Ky	CN	JB	JN	GB	GN	Ga	CB	Je	Residual	Total
Ky	-109										-109
CN	61	0									61
JB	33		85								118
JN				261					1		262
GB					94		27				121
GN						140					140
Ga							-23				- 23
CB	28							0			28
Je									0	--	--
Tot	13	0	85	261	94	140	4	0	1		598

October to January

Origin \ Destination	Ky	CN	JB	JN	GB	GN	Ga	CB	Je	Residual	Total
Ky	-109										-109
CN	2	0									2
JB	64		-46								18
JN	39			0					1		40
GB					-28		30				2
GN						-11					- 11
Ga							-30				- 30
CB	4							0			4
Je									-1		- 1
Tot	0	0	-46	0	-28	-11	0	0	0		- 85

February to May

Origin \ Destination	Ky	CN	JB	JN	GB	GN	Ga	CB	Je	Residual	Total
Ky	-122										-122
CN	2	0									2
JB	56		-39								17
JN	47			-261						249	35
GB					-66		26			40	0
GN						-129				116	- 13
Ga							-30				- 30
CB	4							0			4
Je									-1		- 1
Tot	-13	0	-39	-261	-66	-129	- 4	0	-1	405	-108

Kyenggi Do Province. Storage stocks also accumulated in Chungcheon Nam Do since sales exceeded nonfarm consumption by 251,000 MT. This left 62,000 MT for building storage stocks in Chungcheon Nam Do.

The assignment of just how much grain moves from which province to which province was somewhat arbitrary, but based on the guidelines previously mentioned. Adequate data is not available on interprovincial grain movement. These matrices are not intended to represent all grain movements, but are designed to show major movements if transportation costs are to be minimized and if the indicated criteria for storing grain are met.

The priority of shipments to Kyenggi Do (including Seoul) was first from Chungcheon Nam Do, the from Chungcheon Bug Do, then from Jeolla Bug Do, and finally from Jeolla Nam Do. This means that as deficits developed in Kyenggi Do, they first were filled from Chungcheon Nam Do, and if sufficient supplies were not available there, Chungcheon Bug Do was tapped, etc. For Gyeongsang Nam Do, shipments were first assigned from Jeolla Nam Do, then from Gyeongsang Bug Do, and then from Jeolla Bug Do. Supplies to Ganweon Do were shipped from Gyeongsang Bug Do, and to Jeju from Jeolla Nam Do.

The residuals which appear in the matrix for June to September for rice, and February to May for barley represent excess of farm sales over nonfarm consumption. However, such surpluses are not amounts available for export since no accounting was made for losses in the marketing channel, amounts going into nonfood use such as animal feed and amounts which must be considered as statistical discrepancies. Such amounts are, no doubt, siphoned off throughout the crop year, but adjustments in the matrix data were not made because of lack of information on the extent of such adjustments. Actually, some deficit in domestic supplies of rice is expected to remain in 1981, according to the KASS projections, while a small surplus of barley for food purposes will emerge. In the net, however, total supplies of barley and rice will be close to self-sufficiency levels. Therefore, no imports were programmed in this analysis for 1981.

The primary means of shipment are expected to be by truck. By 1981, the system of expressways and paved secondary roads is expected to be sufficient to allow one day travel between nearly all points in Korea. Truck transportation has already made extensive inroads into rail volume even at distant points from Seoul, such as in the important Honam rice growing region. While rail transport shows a clear advantage in costs per MT-km. over trucks for longer hauls, difficulty in obtaining rail space at peak shipment periods, lack of flexibility in movement of grain, additional handling required, difficulty of assembling full boxcar loads at certain times of the year, and the improved road system have all contributed to the diversion of grain traffic to truck. Unless a major effort is made to improve the rail service for grain shipments, little grain will be moving by rail by 1981. Even with improved rail service, areas close to deficit provinces will be shipping by truck.

Some movement of grain by boat will continue, mostly from Jeolla Nam Do to Gyeongsang Nam Do and Jeju.

Additional Storage Facilities Required

Estimates of available grain storage in 1981 were derived from current storage capacity, capacity of storage under construction, and an estimation of pipeline storage. The capacity data for grain warehouses (excluding wheat) was current as of March, 1972. Assuming that no Class C storages will be available for grain storage in 1981, Class A and B storages as of March, 1972 were reduced by 20 percent to estimate the remaining storage facilities in this class by 1981 (Table 10-14). The depreciation schedule for warehouses is normally over about 50 years. To existing capacity was added the 675 warehouses of 100 pyong each under construction in 1972. All of these warehouses were assumed to be available in 1981. About a half a month's supply of food grain is normally stored in households. Adding amounts in pipeline at the retail and wholesale level, the assumption was made that pipeline storage amounted to about a one month supply for nonfarm consumption in each province.

Table 10-14: Grain Storage Capacities by Province (Excluding Wheat), Projected to 1981

Province	Class A & B Storage 1981 1/	675-100 Pyong Warehouses Under Construction 1972 2/	Estimated Storage In Households, Wholesale & Retail Operations 1981 3/	Total Storage Available	Total Storage Required	Additional Storage Needed
	1,000 MT					
Kyenggi Do	169	41	146	356	356	0
Seoul	(55)	(1)				
Other	(114)	(40)				
Chungcheon Nam Do	49	32	17	98	109	11
Jeolla Bug Do	31	26	10	67	304	237
Jeolla Nam Do	56	42	22	120	453	333
Gyeongsang Bug Do	70	44	38	152	256	104
Gyeongsang Nam Do	80	40	66	186	326	140
Pusan	(38)	(1)				
Other	(42)	(39)				
Ganweon Do	14	20	16	50	50	0
Chungcheon Bug Do	24	20	3	47	105	58
Jeju	4	4	2	10	10	0
Total	497	269	320	1086	1969	883

1/ 80 percent of storage available in March, 1972
2/ Assumes a capacity of 4 MT per pyong
3/ Equal to one month's consumption by nonfarm households
4/ Equal to peak in monthly storage stocks

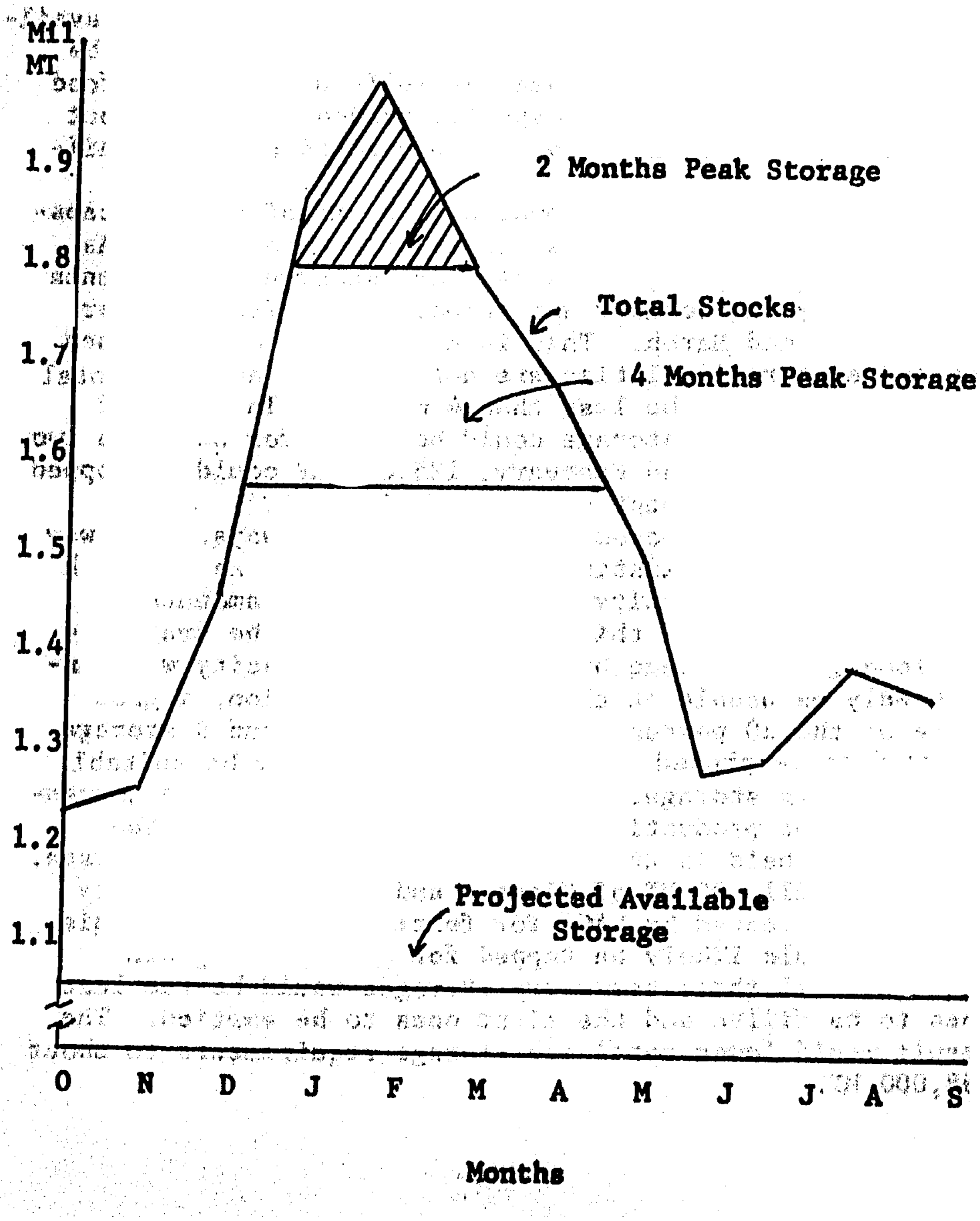
The estimates of total storage available are given in Table 10-14. These estimates are for off-farm storage only and do not include storage at mills and in trucks, rail cars, etc. Also they do not include any new construction planned after 1972.

Grain storage required in 1981 was estimated to be equal to the maximum monthly off-farm storage stocks in each province. Compared with the prospective storage available, a substantial increase in storage capacity will be required by 1981 if Korea becomes self-sufficient in food grains. Total additional capacity needed would be about 883,000 MT, 81 percent above the projected storage available.

Not all of the additional 883,000 MT of storage capacity need be Class A or low temperature warehouses. As shown in Figure 10-1, total off-farm storage requirements rise sharply in December and January, then fall off abruptly in February and March. This is at a period of time when low-temperature facilities are not required and the total storage time would be less than 4 months. In fact, if suitable temporary storage could be found for only the two months of January and February, 125,000 MT could be lopped off the total permanent storage requirement.

This could be accomplished in several ways. One way is to utilize any existing Class C storage. As of March 1972, the total capacity of Class C storage amounted to 514,000 MT. Much of this may not exist nor be available for food grain storage by 1981 but some capacity will undoubtedly be usable at that time. In addition, a good share of the 20 percent of current Class A and B storage assumed to be phased out by 1981 will likely be suitable for temporary storage. These Class C storages are concentrated in the production areas, which would allow the grain to be held in the unhulled form for ease of storage. Also, some 211,000 MT of Class A and B storage capacity is owned or rented by NACF for fertilizer. Part of this capacity could likely be tapped for short term grain storage. All these temporary storages would be the last ones to be filled and the first ones to be emptied. The result would lower total new storage requirements to about 758,000 MT.

Fig. 10-1: Off-Farm Storage Stocks of All Grain and Pulses (Except Wheat), by Months, Projected to 1981-1982



In addition to, or in combination with, the utilization of temporary storages could be a program to retain more grain on farms through the peak off-farm storage season. This would require (1) the extension of more credit to farmers at lower interest rates than obtainable from private sources, and (2) a greater seasonal price rise through the storage season than normally occurs. Assume that the goal was to transfer 225,000 MT of grain from off-farm storage to farm storage for the months from December through March. This would add only 5 to 8 percent to the total inventory of grain on farms during this period. Even if the goal were to clip 350,000 MT from the peak off-farm storage levels in December to March, this would add only 7 to 11 percent to normal stocks on farms in this period. In fact, just after rice harvest, the peak grain inventories on farms would exceed the levels required in December to March if farmers were to hold an additional 350,000 MT.

The capacity exists on farms to hold additional grain for a four month period. As a practice, however, farmers would probably want to build permanent type concrete or brick storage bins to house the additional grain along with grain they would normally store in less suitable facilities. The question, then, becomes one of storage costs on the farm versus storage costs off the farm. There is the additional advantage to on farm storage in that it reduces the pressure on transportation facilities at the peak season. It could also provide extra income to farmers versus nonfarm storage agencies.

If the combination of utilizing Class C storages and storing more grain on the farm were to reduce the peak in off farm storage levels to 1,600,000 MT, the need for additional off-farm storage construction would be lowered to 514,000 MT. The average utilization rate on permanent type off farm storage facilities would be increased from the 77 percent estimated in Table 10-11 to 90 percent. Currently, NACF is planning to build another 315 warehouses of 100 pyong by 1972. Assuming 4 MT of capacity per pyong this would handle about 126,000 MT. In addition, MAF has construction plans which call for 45 warehouses to be built between 1972 and 1976. These would have a total capacity of 270,000 MT. The additional NACF and MAF warehouses would likely be sufficient for storage requirements by 1976, again assuming peak storage requirements were met by using Class C facilities and by holding more grain on farms. Between 1976 and 1981, another 118,000 MT of off-farm storage capacity would be needed unless this additional amount were retained on farms.

Bagged versus Bulk Storage

In a study of farm mechanization by Exotech Systems, Inc. the alternative of storing grain in bulk was considered. 1/ They estimated that existing storage space (Class A, B, and C) could be tripled to about 3.5 million MT if warehouses were converted to bulk storage. If existing warehouses were properly modified for bulk storage, losses of grain in storage now estimated at 17 percent could be cut to around 5 to 7 percent according to Exotech. While bulk storage would also conserve on storage space and aid in mechanizing grain handling a major disadvantage would be the high cost of conversion. The problem of the inadequacy of Class C warehouses would be even more severe than with bag storage.

Exotech believes this alternative should be explored although the Kansas State study team regarded bagged storage as a "given" for the relevant period ahead. 2/ Perhaps some of the new warehouse construction should be designed for bulk storage in order to test this means for future use. However, construction of "flat" storage with reinforced walls rather than silos would provide the flexibility for either bagged grain or bulk grain, and would also have the advantage of being usable for warehousing products other than grain.

1/ Exotech Systems, Inc., "Report on Farm Mechanization Project in Korea," June, 1972

2/ Kansas State University, Review of Grain Storage, Handling, Processing, and Distribution Problems and Proposals in the Republic of Korea, USAID, Seoul, Korea, Sept., 1968

Low Temperature versus Insulated Class A Storage

Upon completion of the 990 small warehouses by NACF, we will assume that myun and ri-dong level storage facilities will be adequate. The question then is what type of the larger warehouses should be constructed. An upper limit can be established for the low temperature warehouses by measuring the nonfarm consumption of rice in May to September. In these months, the average temperature in Korea is above 15oC and the relative humidity rises from 70 to 80 percent, a difficult time for storing rice with 15 to 16 percent moisture. Nonfarm consumption of rice during these months is 1,142,000 MT. The current capacity of low temperature warehouses is only 57,000 MT.

The decision may be between regular Class A storages and low temperature storages. According to the Kansas State study, insulation without refrigeration has limited value. 1/ Annual costs for low temperature storage are about 12,000 won/MT per year, compared with 8,500 won for standard Class A warehouses of similar size. These costs include depreciation and interest. Interest rates were figured at 25 percent per year. If the average utilization level is set at 80 percent, the cost per year would be 15,000 won/MT for the low temperature storage and 10,625 won/MT for the Class A. The difference of 4,375 won represents about 3 percent of retail prices of rice in 1972.

In practice, the utilization levels on the low temperature storage would probably be held above those on Class A storages. With low temperature storage utilization at 90 percent and Class A storage utilization at 75 percent, the difference in cost per MT would be reduced to 2,000 won; only 1.5 percent of the retail price.

Using annual interest rates at 10 percent, more representative of terms available to the Korean government, annual costs are cut in half to 6,000 won/MT of capacity for the low temperature warehouses and to near 4,000 won/MT for the standard Class A. At 90 percent and 75 percent utilization, respectively, the cost difference would be

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1/ Kansas State University, op. cit., p. 61

reduced to about 1 percent of the retail price between low temperature and Class A storage.

Assuming that quantity losses in the two storage facilities are about the same, the decision on which type of storage to build depends on how well the low temperature storage maintains quality relative to the standard Class A. No consumer preference tests have been conducted on rice held in low temperature storage relative to Class A storage. Such tests should be conducted and could very easily be arranged. If consumers can tell a difference, do prefer rice from low temperature storage, and would pay at least 3 percent more for such rice, then the low temperature storages for holding grain through the May to September period would be justified. Further investments in low temperature storage should be determined by the results of the consumer preference research recommended.

On-Farm versus Off-Farm Storage Costs

Somewhat sketchy information indicates that farmers can construct concrete storage bins on their farms for around 10,000 won to 20,000 won per pyong. Each pyong is assumed to hold 2 MT. The interest cost in such an investment would be 1,250 won to 2,500 won/MT per year at a 25 percent interest rate, and depreciation would amount to 200 won/MT to 400 won/MT, a total of 1,450 won/MT to 2,900 won/MT. Inputed interest by storing the crop would amount to 30,000 won/MT per year assuming producer prices at 9,600 won/bag (as proposed for 1972) at harvest. With general inflation at 1 percent per month, another 1,200 won is added to storage costs. How much more farmers might require to cover their labor costs for handling the storage, for maintaining quality of the grain, for incurring shrinkage, and for assuming physical and price risks is difficult to determine. In all likelihood producers would require at least a price rise of 4,500 won/MT per month to encourage them to store, and only then if they could obtain needed credit for 2 percent per month. A 4,500 won/MT per month price rise would amount to about 3½ percent of the harvest price per month. With interest rates at 10 percent per year, a price rise of 3,000 won per month would likely be sufficient.

In the crop years from 1965-66 to 1971-72, the farm price of rice increased an average of about 17 percent from November to May, about 2.8 percent per month. Farmers would have to be assured of more of a price rise than this to encourage them to store, and then only if credit were readily available at no more than 2 percent per month.

We estimate that the facility costs for storing grain on farms is less than for the large Class A warehouses. This is the case even using the upper bound of the 10,000 - 20,000 won/pyong estimated by farmers for building cement storage bins. While the figures are rough, we can consider adequate on-farm storage facilities to cost a maximum of about 1,500 won per MT of capacity per year at 10 percent interest, and about 3,000 won per MT at 25 percent interest. This compares with 4,000 won and 8,500 won/MT of capacity, respectively, for the large Class A warehouses.

While we have no measurement of quality deterioration of grain in cement graneries on farms versus large Class A warehouses, we feel that farmers could probably manage four to five months storage in the late fall and winter without incurring substantial quality problems.

The benefit stream from such an investment could be derived from the cost saving relative to constructing large Class A warehouses, and from savings in transportation costs due to higher rates often charged right after harvest. To build farm storage to handle the 350,000 MT peak in total storage projected for 1981 that normally would be in off-farm positions, cost savings would amount to from 875 million won to 1,380 million won per year.

Transportation charges in the peak season around rice and vegetable harvest have been reported to be as much as double the rates during other times of the year. 1/ A saving of even 25 percent of the transportation cost on moving 350,000 MT of grain locally (20 km.) would amount to 210 million won. Some additional benefits would be derived from longer range hauls.

1/ Kim, Chung Ho, "Influence of Road Class and Means of Transportation on Farm Enterprise Distribution, Hwasung, Gun, Kyenggi Do Province Republic of Korea," USAID/RDD, Sept., 1970, p. 24.

Another side benefit would be the possibility of more timely application of lime. According to Bai, Yung Sung, "....if limestone can be transported during the winter, the leisure period in farming, competition of labor will be reduced, and there is the further advantage of direct trucking of limestone onto the farm land when the ground is frozen. From the standpoint of the railway and trucking companies, however, because the demand for hauling fuels and agricultural products is very heavy in the winter time, the priority of limestone for transportation is low." 1/ In practice, transportation of lime is concentrated in June, July, and September when there are heavy demands for labor for other farm work.

Efforts to expand farm and village storage facilities could well have the important by-product of improving existing facilities. Since over half the grain and pulses stored in Korea is on farms, reduction of losses in farm storage could potentially have a significant impact on food supplies. In a sample survey of 300 farms, estimated losses in home storage were about 13 percent of the grain so stored according to the Kansas State study. 2/ These farmers estimated that 88.7 percent of their storage losses were due to rodents, 7.5 percent to insects, and 3.8 percent to spoilage. This compares with 10 percent losses for government controlled rice in 1966.

Farmers we interviewed who had cement storage bins reported that they had no losses in quantity nor quality, only the normal shrinkage. Those who did not have cement bins indicated that they would build them if they were to store more grain on the farm. From this endorsement of cement storage bins, it would seem reasonable that farm losses from storage could be reduced to 5 percent with adequate facilities and reasonable good management.

1/ Sung, Bai Yung, An Economic Analysis of Use of Agricultural Lime by Farmers, Department of Agricultural Economics, Seoul National University, May, 1970, pp. 30-31

2/ Kansas State University, op.cit., p. 48

If losses from storage on farms were reduced from 13 percent to 5 percent, what would be the possible payoff to cement bin storage? The investment would be approximately 1,500 won to 3,000 won/MT depending on the interest rate. Maintenance costs were assumed to be about 30 won/MT per year. The total amount of storage required on farms in 1972 was estimated to be 4,500,000 MT. This is the level of inventories of grain and pulses on farms at the end of November according to estimation procedures described elsewhere in this report. Storage on farms generally reaches a peak in November following rice harvest. If the pattern of selling grain and pulses from farms in 1981 remains about the same as in recent years, and if production increases as indicated in the KASS study, storage capacity on farms would have to increase to 6,000,000 MT by 1981.

If cement bins were to replace more traditional storage facilities in 1972, the total cost would be approximately 6,741 million won (at 10 percent interest), or 13,482 million won (at 25 percent interest). Adding maintenance costs, the discounted cost of the investment from 1972 to 1981 would be 6,948 million won at 10 percent interest, and 11,210 million won at 25 percent interest.

The benefit stream was calculated by taking the estimated stocks on farms on February 1 as an indication of the amounts stored on the average. This was about 75 percent of the peak storage. The value of cement bin storage was estimated to be equal to 8 percent of the average amount stored. Using 1972 rice prices of 130,000 won/MT, the discounted value of this saving amounted to 218,620 million won (at 10 percent) over the 1972-1971 period and 123,139 million won (at 25 percent). This gives a benefit-cost ratio of 31.5:1 at 10 percent interest, and 11.0:1 at 25 percent interest. Allowing for somewhat lower prices on barley lost in storage, the benefit-cost ratios would be about 30:1 and 10:1 respectively

Suppose farmers were encouraged to retain enough additional grain on farms to handle the 350,000 MT peak in off farm stocks projected to 1981. The additional cost to retain this amount would be about 1,400 million won discounted over 1976-81 at 10 percent, and 1,940 million won discounted at 25 percent. These estimates were derived from a gradual expansion over the 1976-81 period to reach the additional 350,000 MT capacity by 1981. The investment was delayed until 1976, since the additional storage would not be required until then. No savings from reduced losses were calculated for the value stream assuming that losses in off-farm storage would be no greater than in cement bins on farms. The benefits are derived from the lower construction costs for on farm storage and the possible savings in transportation costs. The savings in transportation costs were estimated at 25 percent of the cost of moving 350,000 MT over a distance of 20 km.

These benefits accumulated to 2,750 million won and 2,412 million won at 10 and 25 percent interest, respectively, over the 5 year period. This resulted in benefit-cost ratios of 2.0:1 and 1.24:1, respectively.

Storage Requirements in 1971-1972

Following a procedure similar to that outlined for calculating hypothetical storage-transportation requirements in 1981, such requirements were estimated for the current period -- specifically 1971-1972. Again, carryover levels on rice for October 1 were set at a two month's nonfarm supply, and June 1 barley stocks were also set at a two month's supply. Stocks of other grain and pulses (except wheat) were held constant year around since they are mostly on an import basis or are of minor importance. Consumption levels are somewhat less than actual 1971 figures since population by provinces is for 1969.

Table 10-15 shows the hypothetical stocks of grain and pulses for 1971-72 for October, February, and June. The top section includes only indigenous grain. The botton section shows the accumulation of imports in April and May for consumption in June and July. A two month's lead time in imports is assumed.

Based on these estimates, the current level of grain storage in Korea is adequate, taking into account the capacity of Class A and B storage available in March, 1972, the 675 small warehouses under construction in 1972, and pipeline storage (Table 10-16). At times of the year,

Table 10-15: Hypothetical Stocks of Grain and Pulses (Except Wheat) in Off-Farm Storage, October 1, February 1, and June 1, 1971-1972

Province	Rice			Barley			All Grain Excl. Wheat		
Indigenous	Oct.1	Feb.1	Jun.1	Oct.1	Feb.1	Jun.1	Oct.1	Feb.1	Jun.1
	1,000 MT								
Kyenggi Do	150	236	151	33	33	33	199	285	200
Chungcheon Nam Do	18	78	18	4	4	4	24	84	24
Jeolla Bug Do	14	55	39	3	3	3	18	59	43
Jeolla Nam Do	22	37	38	145	77	5	170	117	46
Gyeongsang Bug Do	39	70	39	65	51	9	108	125	52
Gyeongsang Nam Do	57	66	57	92	79	12	155	151	75
Ganweon Do	16	33	16	4	4	4	22	39	22
Chungcheon Bug Do	8	28	15	2	2	2	11	31	18
Jeju	2	3	2	5	5	-	8	9	3
Total	326	606	375	353	258	72	715	900	483
Imported									
Kyenggi Do			104						
Gyeongsang Bug Do			19						
Gyeongsang Nam Do			41						
Ganweon Do			14						
Jeju			2						
Total			180						

Table-10-16: Grain Storage Capacity by Province (Excluding Wheat), 1972

Province	Class A and B Storage March,'72	675-100 Pyong Warehouses Under Construction 1972	Estimated Storage In Households, Wholesale & Retail Operation 1972	Total Storage Available	Total Storage Required	Excess
	-----	-----	1,000 MT	-----	-----	-----
Kyenggi Do	211	41	100	352	312	40
Chungcheon Nam Do	61	32	12	105	84	21
Jeolla Bug Do	39	26	9	74	59	15
Jeolla Nam Do	70	42	15	127	149	-22
Gyeongsang Bug Do	87	44	26	157	125	32
Gyeongsang Nam Do	100	40	38	178	179	-1
Ganweon Do	18	20	11	49	39	10
Chungcheon Bug Do	30	20	5	55	32	23
Jeju	5	4	2	11	10	1
Total	621	269	218	1,108	989	119

some tightness in storage may develop in Jeolla Nam Do and Gyeongsang Nam Do. The large barley crop in Jeolla Nam Do may put some pressure on local storage facilities near rice harvest time. The accumulating imports of rice in the early summer may also tax current facilities in Gyeongsang Nam Do, according to these calculations.

In both cases, Class C storage facilities could be used for short periods to handle the peak loads. For the nation as a whole, storage capacity for grain appears to be adequate. Considering the current plans for constructing new off-farm storages, the total capacity will be adequate until the latter part of this decade. But in the meantime, investments in new cement bin storages on farms could result in substantial savings in storage costs because of the potential reduction in storage loss. Improved and expanded on-farm storage facilities could also take some of the peak pressure off the demand for commercial storage.

Chapter 11

Demands on Transportation Facilities and Benefits From Road Improvement

The role of transportation in the development of rural areas is generally recognized as vital -- but difficult to assess. Increasing commercialization of agriculture in Korea will be accompanied by more than a doubling of farm marketings and purchases of inputs in just 10 years. Such growth as anticipated in the KASS simulation model is not automatic, but must be fostered by improved roads. Mechanization of agriculture, upland development, improved communication and education are all dependent on the adequacy of the rural road system. Social and cultural benefits also accrue to improved roads, and are of marked concern to the Korean government now attempting to make rural areas a more attractive place to live.

Measurement of all these benefits is beyond the scope of this study. An analysis by the Ministry of Home Affairs calculated benefit-cost ratios of rural road development in three villages, at 1.87, 11.37, and 2.16 for a 21 year period at 15 percent interest. 1/ Our objective will be to focus on the singular benefits which would be realized in the handling and marketing of farm products, and the purchases of farm inputs. These benefits will be compared with costs of improving rural roads. If reasonable benefit-cost relationships can be demonstrated for movement of agricultural materials alone, the argument would be even stronger when considering the important other benefits.

Volume Transported

First an estimation was made of the total volume of products farmers handle between their fields and their villages. The total production of grain, pulses, potatoes, vegetables, and fruit amounted to 10,786,000 MT in 1971,

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1/ Ministry of Home Affairs, Study on Economic and Social Effects of Rural Road Development, Korea.

and is projected to 15,444,000 MT in 1981. In 1971, farmers also produced about 11,520,000 MT of straw. An estimated 2,870,000 MT of roughage was fed to dairy and Korean cattle. By 1981, straw production would be expected to remain at about 11,326,000 MT, and the roughage requirement by that time may be around 3,336,000 MT. In 1971, an estimated 20,730,000 MT of manure was transported from villages to fields. This amount would be expected to reach 24,088,000 MT by 1981. Including straw, roughage, and manure, the total amount of farm product moved between fields to farms and villages is estimated at 45,906,000 MT in 1971 and projected to 54,194,000 MT by 1981.

Total fertilizer and lime used on Korean farms is estimated at 1,640,000 MT in 1971, and projected to 3,710,000 MT in 1981. Pesticide consumption was estimated at 25,000 MT in 1971, and is projected to 36,000 MT by 1981. The total of farm products and inputs moved between field and village then would amount to 47,571,000 MT in 1971, and 57,940,000 MT in 1981.

If the average distance moved is two-thirds km., the volume of transportation requirement would be 31,700,000 MT-km. in 1971, and 38,600,000 MT-km. in 1981. (See Appendix II for determination of distances used in this analysis.)

Next, estimates were made of the total volume of products sold from farms in 1971 and 1981. These were derived from the KASS simulation model by deducting farm consumption from production (adjusted downward for on farm losses). Since grain is generally taken to a nearby mill for hulling and polishing, farm consumption of grain was included in the volume moving off farms.

Also added to the amounts of product moved were the quantities of the major inputs -- fertilizer, pesticides, and fuel -- sold to farmers. These data are compiled in Table 11-1.

These amounts represent the bulk of product flow over feeder roads from village to truck road, mill, or 5-day market. If we assume that the average distance from a village to a truck road is 1 km., then the total product flow would be roughly 9,867,000 MT-km. per year. Since an estimated 20 percent of the farm products are from villages not accessible by truck, this bottleneck would involve a flow of about 1,983,000 MT-km. in 1971, and 3,377,000 MT-km. in 1981.

Table 11-1: Annual Sales From Farms, Farm Consumption of Food Grains and Purchases of Input, 1971 and 1981

Item	1971 1,000 MT	1981 1,000 MT	Ratio 1981 - 1971
Farm Sales			
Rice	1371	2882	2.10
Barley	602	1185	1.97
Wheat	13	381	29.31
Other Grain	59	53	.90
Pulses	164	276	1.68
Potatoes	418	1283	3.07
Vegetables	1365	2333	1.71
Fruit	321	731	2.28
Beef	37	95	2.57
Milk	42	146	3.48
Pork	61	107	1.75
Chicken	46	148	3.22
Eggs	103	304	2.95
Total	4602	9924	2.16
Farm Consumption Of Food Grain	3601	2715	.75
Purchases of Fertilizer, Lime and Pesticides	1665	3748	2.25
Fuel, Oil (Est.) 1/	50	500	10.0
Grand Total	9917	16,887	1.70

1/ For power equipment

Distance Traveled

The next step to be analyzed in the marketing channel is from the truck road to the ultimate consumer within the province. This distance is assumed to be 20 km., of which 19 km. is not paved. The volume of product moved would be approximately equivalent to nonfarm consumption within a surplus producing province and total farm sales in a deficit province. To these sales would be added the amount of fertilizer, lime, fuel, and pesticides purchased by farmers.

If we assume that sales of farm products destined for markets outside the province must travel about the same distance over unpaved roads as products destined for sale within the province, then total farm sales plus input purchases times 19 km. would give the MT-km. movement over unpaved roads. This would amount to 120,023,000 MT- km. in 1971, and 269,268,000 MT-km. in 1981.

Cost of Transportation by Modes

Modes of transportation were divided into the following categories: (1) A-frame, (2) bicycle, (3) hand cart, (4) ox cart, (5) tiller, (6) taxi or car, (7) small 2 ton truck, (8) large 6 to 8 ton truck. Some estimates of cost on (1), (3), and (4) were obtained from a formula of the Labor Standard Law. 1/ Other estimates were compiled from various studies, by interrogation of farmers and local officials and by the judgement of individuals familiar with rural life in Korea.

A-Frame

The A-frame is a back pack traditional in Korea and its use seems to persist even in situations where other

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1/ Ministry of Home Affairs, Study on Economics and Social Effects of Rural Road Development, Korea.

modes of transportation are possible. It has multiple uses and is flexible in that it can be used wherever man can walk, and provides a platform for holding materials when set down from the back. In any case, the Korean view of the A-frame is changing, and more convenient modes will be eventually adopted when such adjustment is possible.

An estimate was made that one could carry about .05 MT (50 kg.) on each trip at a speed of about 2.5 km. per hour. Labor costs in rural areas have been running about 600 won to 700 won per day, assuming an 8 hour day. In the near future, wage rates will likely be closer to 800 won per day, so 100 won per hour was set as the wage rate. As long as underemployment exists, the opportunity costs of labor will be less than this. We assume, however, that increases in off-farm employment for rural people will raise opportunity costs to this wage rate in the future. Using 100 won per hour, the cost per MT-km. of transporting by A-frame would be 1,600 won, assuming the carrier would have no load one way. No adjustments were made in the speed for gradients or passing other pedestrians or vehicles. The time required for loading and unloading is estimated at 5 minutes, or about 166 won per MT. The cost of the use of the A-frame would, of course, be minimal.

In estimating the costs of transporting products between farm and field by A-frame, we use an average distance of two-thirds km. 1/ To transport a metric ton of product or input would require 20 trips, taking 13.33 hours for travel and 100 minutes for loading and unloading. The cost would amount to 1,500 won (15 hours X 100 won/hr.).

The A-frame would not likely be used to transport products much further than a one day trip. At 2.5 km. per hour, this would be approximately 8 km. The average distance to a 5-day market or local trading-shipping center was estimated to be 3 to 4 km. At 3.5 km., the 20 trips required to transport a metric ton would take 56 hours. This, plus the hour and forty minutes for loading and unloading, would cost 5,767 won per MT.

1/ In plain areas, distance would be somewhat less than in upland areas.

If the village were 8 km. from the market or distribution point, the 20 trips would take 138 hours. Total costs would amount to nearly 13,000 won per MT.

Bicycle

No definitive data were available on the costs for bicycle transport. What is known is that about 2 bags of rice (80 kg. per bag) can be transported by bicycle. Assuming that the average village to market feeder road would allow bicycles to travel about 4 times the speed of a person walking with an A-frame, the bicycle would cover 10 km. per hour. The labor cost would be 125 won per MT-km. plus the time loading and unloading. The use of the bicycle could be charged at about 300 won per day.

Assuming a bicycle could travel only 3 times faster than a man between villages and fields, the cost per MT moved would be 225 won. Between villages and markets at a speed of 10 km/hour, the cost would be 675 won/MT to travel 3.5 km. and 1,450 won/MT to travel 8 km.

Hand Cart

One man and a hand cart are assumed to handle .25 MT per trip at an average speed of 2.5 km. per hour. The labor cost per MT-km. would figure out to be 320 won. Rental rate on a hand cart is about 250 won per day which can be used as a basis for estimating a charge for the hand cart. Including a charge for labor and hand cart, total costs would be 420 won/MT-km. Allowing four minutes for loading and unloading would add 27 won/MT on each trip.

On village to field travel, to move one metric ton would require 4 trips each taking about .6 of an hour. This would be a labor cost of 240 won per MT. The charge for the cart would be about 75 won per MT for a total cost of 315 won per MT transported between field and villages at an average distance of two-thirds km.

On village to market shipment of an average 3.5 km., the four trips would take 11.2 hours travel time plus about fifteen minutes for loading and unloading for a total labor cost of 1,150 won. The charge for the hand cart would be 350 won for a total of 1,500 won per MT transported. At 8 km. from the market, the labor cost would be 2,600 won and the cart charge would be 800 won for a total cost of 3,400 won per MT.

Ox Cart

Standards have been established for ox carts at a load of .8 MT per trip with an average speed of 3 km. per hour. The average loading and unloading time was set at 11 minutes.

The charge for the ox and cart is of some consequence in contrast with the A-frame, bicycle, and hand cart. A farmer who has an ox and cart would incur little additional expense by using this mode for transportation except, perhaps, the loss of revenue that might be available by renting his ox and cart to others. If the farmer has to rent this equipment or hire others to use their equipment, then the cost is considerably greater.

The daily rental fee for an ox is about 700 won (1972). The daily rental on a cart plus the feed costs would add around 500 won for a total daily charge of 1,200 won. At 7 hours of traveling time per day, a pay load of .8 MT could be moved about 10 km, i.e. 8 MT-km. The cost would be 150 won/MT-km., plus a labor charge of 100 won/MT-km., for a total of 250 won/MT-km. Depending on opportunity costs, one might calculate the cost of transportation by ox cart at nil won/MT-km. (zero opportunity costs for farmer's labor, ox and cart); 100 won/MT-km. (full wages for farmer, zero opportunity cost for ox and cart); or the full 250 won/MT-km. --- or points between, depending on the particular situation.

NACF collects data on charges for agricultural services including cartage by ox or horse. In 1972, the cost for transporting a bag (80 kg.) over a distance of 5 km. was about 50 won. This figures out to be 156 won/MT-km. This cost is less than the full cost based on rental rates for ox and cart, but is above the cost derived from labor alone. This seems like a reasonable rate considering that a number of farmers probably are willing to provide custom service at less than total unit costs.

For transportation between villages and field, an average of about 1.25 MT could be moved per hour over the approximately two-thirds km. Because more time would be spent loading and unloading per MT-km. than with the longer hauls, the labor cost would be somewhat higher than for rates set for 4 km. Using 195 won/MT-km., the cost per MT transported would be 130 won.

For farm to market transportation, covering a distance of 3.5 km. would cost about 546 won/MT. Traveling 8 km. to market would cost 1,248 won/MT.

Power Tillers

Mechanization on Korean farms is in an early stage. In 1971, there were only 17,000 power tillers in Korea or a total of 14 per 1,000 hectares of paddy land. This compares with 936 per 1,000 hectares in Japan. According to a proposal by Exotech Systems, Inc., the number of power tillers in Korea could cumulate to 161,000 between 1973 and 1982. 1/ Paddy land mechanized would, thus, increase from 26,000 hectares in 1973, to 522,000 in 1981, and 647,000 in 1982. By 1982, 90 percent of all paddy land on rice and rice/barley farms of one hectare or larger would be mechanized. This would cover about 50 percent of the current paddy land area.

The introduction of power tillers to Korean agriculture will have a major impact, not only on cultivation techniques, but also on marketing and transportation of farm products and inputs. In a survey conducted for Exotech by Kim, Sung Ho, Agricultural Economics Research Institute, 11 grain farmers with power tillers utilized them approximately 700 hours per year. Of this time, 35 percent was devoted to transporting agricultural materials.

1/ Exotech Systems, Inc., "Report on Farm Mechanization Project in Korea," June, 1972.

a 1970 survey of about 100 tiller owners in the Jeju area found that transportation of agricultural materials and fertilizer was the most frequent operation performed with the tiller. 1/

As suggested in the Exotech study, a standard power tiller unit would be a 10 horsepower kerosene type. This is expected to be the most popular and practical unit. Such a unit with a trailer would normally be expected to carry a 1.2 MT load at an average speed of 20 km. per hour. 2/ For travel between village and field, a speed of 15 km. per hour was assumed. The labor cost would be 8.25 won/MT-km. with a one-way load on a round trip, plus a labor cost of 15 won/MT for loading and unloading. Exotech estimated custom rates at 335 won per hour for tiller and trailer for transportation purposes. It is assumed that these rates include the labor of the operator.

Exotech justified the expansion in the use of power tillers on the basis of (1) labor savings, (2) animal savings, (3) increments to grain yields due to better timing in planting and harvesting, better seed bed preparation and power spraying, and (4) income from use of tillers for haulage. Many owners do custom work with their tillers. The introduction of tillers will be primarily to mechanize production operations with transportation being an important supplementary use mostly during the slack season. For this reason, one could figure the costs of transportation from the marginal cost for fuel, labor, and some additional depreciation. Alternatively, the annual depreciation and other fixed costs of owning a power tiller could be assigned to transportation on the basis of the proportion of operational time devoted to transportation. This was selected as the preferred method of computation with transportation representing one-third of the operational time.

1/ A study conducted by Lee, Jeung Han, Associate Professor of Agricultural Economics, Chinju Agricultural College.

2/ Estimates obtained from AERI surveys on an 8 HP power tiller showed a range of .8 to 1.5 MT load and a speed of 15 to 20 km. per hour.

Estimates by Exotech for rice and barley farms indicate a price of 264,000 won for a power tiller (not including attachments), and 45,100 won for the trailer. 1/ Assuming repair and maintenance at 10 percent of the purchase price, an annual repair and maintenance cost of 26,400 won for the power tiller and attachments plus 4,510 won for the trailer was computed. Life expectancy was set at 7 years with a 10 percent salvage value at the end of 7 years. Using the straight line depreciation method, there would be an annual depreciation on the power tiller of 33,983 won and on the trailer of 5,793 won. Total repair, maintenance, and depreciation, plus interest cost at 10 percent per year would amount to 86,845 won on the tiller and 14,813 won on the trailer. At 25 percent interest, the costs would be 126,491 won and 21,577 won, respectively.

Assigning one-third of the fixed cost on the power tiller, and all of the fixed cost on the trailer to transportation, the total fixed cost per year would amount to 43,761 won at 10 percent interest, and 63,740 won at 25 percent interest.

Assuming that the power tiller will be used about 700 hours per year of which 233 hours (one-third) will be for transportation purposes, the fixed cost would amount to 188 won per hour at 10 percent interest, and 274 won per hour at 25 percent interest. Fuel and oil costs were calculated to be about 150 won per hour. 2/ Assuming the

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1/ Exotech Systems, Inc., op. cit. p. VII. 17.

2/ This was estimated from standard performance tests cited in the Exotech study, p. VII. 14 and ADXII. 1. For a 4 cycle kerosene engine, fuel consumption is estimated at .53 l. per HP-hour, or about 5.3 l./hour for a 10 HP engine. Lubricating oil consumption is about 1 liter of oil to 50 liter of fuel. Kerosene prices were assumed to be 30 won per liter.less 5 won sales tax and custom duty. From a survey by AERI on 8 HP power tillers, kerosene consumption of 24 liter per hour was indicated, which was less than used in the Exotech study.

wage rate for the operator at 100 won per hour, total costs would amount to 438 won per hour at 10 percent interest, and 524 won per hour at 25 percent interest. With custom rates at 335 won per hour, the owners apparently are not covering total unit costs, but are exceeding marginal costs. This is a rational practice in that custom hauling is a supplementary activity for most farmers with power tillers.

For this analysis, total costs were used rather than custom rates since the option of custom hauling may not be as readily available when most farms acquire power tillers or share their use.

For transportation between farm and field, an average of 4.4 MT could be handled each hour. This would amount to a total cost of about 100 won per MT at a 10 percent interest rate, and 120 won per MT at a 25 percent interest rate. These costs are somewhat less than the rates for ox cart transportation.

In moving products to or from markets 3.5 km. away, about 2.25 MT could be transported in an hour, assuming an average speed of 20 km. per hour. The total cost would be 195 won per MT at 10 percent interest, and 244 won per MT at 25 percent interest. For farms 8 km. away from markets, the costs would amount to 359 won/MT at 10 percent interest, and 430 won/MT at 25 percent interest. These costs are perhaps half or only a third of the costs by ox cart.

Disregarding loading and unloading, the power tiller would provide transportation for about 36 won/MT - km. to 44 won/MT per km. at a speed of 20 km. per hour.

Taxi or Car

Use of a taxi or car is mentioned frequently as one means of transporting agricultural materials. Assuming the capacity to be up to .32 MT, the equivalent of 4 adults, the cost per MT-km. (excluding loading, unloading costs) is estimated to be 213 won to 278 won/MT -km., depending on the rate of interest. Actual charges to farmers are greater since taxes were excluded.

These estimates are based on travel over a gravel road. If the road were paved, the costs would be reduced to 170 won to 235 won/MT -km. 1/ As expected, these costs are considerably above those for operating a power tiller.

Small Truck (3 Wheeled, 2 Ton)

A 3 wheeled, 2 ton truck is popular in Korea and, in the process of mechanizing rural Korea, will serve to bridge the gap between transportation by power tiller and the long range transportation by large truck. It will also be used in direct farm pick up as the feeder road system improved. Recent prices on these trucks were around 1,290,000 won without tax.

Operational costs were estimated at 39 won per km. if the road was gravel. Labor cost was assumed to be fixed, amounting to 13.3 won per km. if 27,000 km. were covered each year. Depreciation and interest per km. amounted to 10.5 won to 17.7 won at a 10 and 25 percent interest rate, respectively. Taxes were excluded. Assuming the vehicle would be empty half the time, the cost per MT-km. ranged from 63 won to 70 won. This would be well under taxi costs, but above those for a power tiller. By paving the road, total costs would be reduced to between 52 won and 59 won/MT -km.

Large Truck (8 Ton)

Under the same driving conditions and for the same number of km. per year, costs per km. on a 6 to 8 ton truck would be substantially higher than on the small truck. But because these trucks are used for long distance hauling over more paved roads than the smaller trucks, costs per km. traveled are only moderately higher based on experience of trucking companies in Korea.

1/Winfrey estimates that operational costs for an automobile on a gravel road are 50 percent higher relative to a standard, level tangent, paved road. For a truck, the increase is 40 percent. See Winfrey, Robley, Economic Analysis for Highways, International Textbook Co., Scranton, Pa. 1969

The cost of an 8 ton truck is about 3,800,000 won without a 20 percent tax. Assuming 78,000 km. will be covered each year, depreciation and interest costs were estimated to be between 10.2 won and 17.5 won per km., depending on the interest rate used. Labor costs would amount to 8.9 won per km. and operational costs were set at 58 won per km. if the road traveled were gravel.

If the truck were empty half the time, costs per MT-km. would range from 19 won to 21 won. Paving the road would reduce this cost to 15 won to 17 won, respectively. These costs suggest that the economies of the larger trucks are such that there would be substantial savings in transportation, the closer these vehicles could get to the producing area for full loads. Table 11-2 summarizes the transportation costs by mode.

Costs of Feeder Road Construction

A discussion of the cost of constructing a feeder road was presented in Chapter 7. Drawing from that discussion, estimates were made of average costs for future road construction. Wage rates were adjusted to the 100 won per hour or 800 won per day assumed in the estimation of the costs of transportation by mode. Land costs of 200 won per pyong to 700 won per pyong were used. The 200 won represents the 1970 value of land per cultivated pyong in the Farm Household Economy Survey. The 700 won per pyong represents the figure reported to us by farmers and would indicate recent prices of good farm land. Both figures were used to cover costs on different types of land.

Labor required to build a 3½ meter feeder road was assumed at 400 man days per km. This would amount to 320,000 won per km. Land costs were figured at 4 meters for 3½ meter road, which amounts to 240,000 to 840,000 won per km. Material costs were set at 114,000 won per km., and the land survey at 12,000 won per km. This totals to about 700,000 to 1,286,000 won per km., or about 200,000 to 367,000 won per meter of width on one km. of road.

Table 11-2: Estimated Cost of Transportation by Mode, at 10 Percent and 25 Percent Interest, 1972 1/

Mode	------- Place of Travel -------		
	Farm to 2/ Field- (2.3 km.)	Farm to 2/ Market- (3.5 km.)	Truck 3/ Road
	W/MT	W/MT	W/MT-km.
At 10% Interest			
A-frame	1500	5767	--
Bicycle	225	675	
Hand Cart	315	1500	
Ox Cart	130	546	
Power Tiller	100	195	36
Taxi or Car - Paved			170
Unpaved			213
Small Truck - Paved			52
Unpaved			63
Large Truck - Paved			15
Unpaved			19
At 25% Interest			
A-frame	1500	5767	
Bicycle	225	675	
Hand Cart	315	1500	
Ox Cart	130	546	
Power Tiller	120	233	44
Taxi or Car - Paved			235
Unpaved			278
Small Truck - Paved			59
Unpaved			70
Large Truck - Paved			17
Unpaved			21

1/ Costs assume full load for half of trip.

2/ Loading and unloading time included.

3/ Loading and unloading time not included.

Benefit-Costs on Village to Field Roads

No estimates are available on the condition of village to field roads. Except for those fields which happen to be located near a truck road connecting villages, few fields are likely to be accessible by truck. A realistic goal would be to make most major fields accessible by power tiller since the volume and distance involved would not warrant a truck. As indicated by the costs per MT - km a big step would be to make fields accessible by hand cart. Converting from A-frame to hand cart could result in a saving of 1,180 won per MT - km. . if 100 won per hour is a true reflection of the wage rate and the opportunity cost for labor in rural areas. Another 200 won per MT - km. could be saved if ox carts could be used, and even more saving would result by introducing power tillers if fully utilized.

In a village whose fields are not accessible except on foot, assume 2.5 km. of pathways would have to be widened to enable transportation by hand cart, ox cart, or power tiller. A pathway would be about 1.0 to 1.5 meters wide. If widened to 2.5 to 3.0 meters, ox carts could be used and it would even be possible for two push carts to pass or an ox cart could be passed by another man on foot. 1/ Widening the paths by 2 meters would cost around 400,000 won per km., or a total of 1,000,000 won if land was priced at 200 won per pyong. At 700 won per pyong, the cost would total about 1,837,000 won. 2/

Maintenance cost is estimated at about 10 percent of the labor input, or about 50,000 won per year. Over a 10 year period from 1972 to 1981, total outlays would amount to 1,450,000 won (land at 200 won per pyong), with

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1/ See Yamazak, Farmland Development for width of road required for various transportation modes as reported in Study on Economics and Social Effects of Rural Road Development, Ministry of Home Affairs, Korea.

2/ See Appendix III for details on costs of feeder road construction.

a discounted value of 1,169,000 won at 10 percent, and 936,000 won at 25 percent. At the end of the 10 year period, the depreciated value of the feeder road is estimated to be 50 percent of the initial cost. A 20 year life is, thereby, assumed for the feeder road. Charging land at 700 won per pyong, the discounted costs would be 1,930,000 won at 10 percent, and 1,600,000 won at 25 percent.

An estimated 47,571,000 MT of products and inputs were moved between farm and field in 1971 in Korea. As there are 44,000 villages of 10 or more households (97 percent of all households included in the classification), the average volume moved per village would be 1,080 MT per year. By 1981, with 57,940,000 MT to be transported, the average per village would increase to 1,310 MT.

Starting from the extreme situation in which fields are accessible only on foot, assume that by 1981 all transportation is by power tiller, the investment in the feeder road is made in 1972, and the transition from foot transportation to power tiller is linear from 1972 to 1981. The benefit-cost ratio from this investment would be 4.3:1 assuming a discount rate of 10 percent, and 2.3:1 assuming a discount rate of 25 percent. If a transition would be made immediately to ox cart, then eventually to power tiller, the benefit-cost ratio would be 7.4:1 at 10 percent, and 5.0:1 at 25 percent. This alternative would seem to be the most realistic.

Even if many farmers continue to use their ox carts rather than shifting to the power tiller, the benefits would exceed the costs. If half of the volume moved by tillers and half by ox cart in 1981, the benefit-cost ratios would be 7.5:1 and 5.0:1, respectively.

The benefits in these calculations are solely from the cost saving in transportation. Other likely benefits would be higher yields due to increased and more timely application of fertilizer, lime, pesticides, etc. and the collection of net benefits associated with mechanization. Clearly, the sum total of these and other benefits could be substantial.

How much of a deterrent poor roads or no roads are to these additional sources of benefits can only be roughly estimated. Also, the possible benefits to such changes in cultural practices cannot be measured as a part of this analysis. Drawing from other studies, some idea of the extent of these additional benefits can be obtained.

One study of lime application in 42 villages in Kyenggi Do Province in 1969 revealed that problems with transportation were a major deterrent to increased use. 1/ Only 591 (about 30 percent) of 2,032 farms had applied lime in 1965-68. Of these, 557 were selected for detailed study. Farms with arable land on good roads accessible to trucks applied an average of 7.5 tons per farm over the 1965-68 period, twice the quantity for farms not accessible by trucks. Only 11 percent of the farms were directly accessible by truck, however. There was also a significant difference in use of lime between villages accessible by truck and those which were not. Of the 42 villages, 34 could be reached by truck. In these villages, the proportion of farms using lime was 32 percent. In the 8 other villages, only 11.4 percent of the farms used lime. This figures out to be .55 MT per farm in villages accessible by truck and .23 MT per farm in villages not accessible by truck.

While no information was obtained on the type and conditions of the feeder roads leading to the fields, one third of the farmers who used limestone transported it by A-frame. Another 4 percent used the backs of their cattle. The remaining 62 percent used hand carts, ox carts, and tractors. When asked "If road conditions were improved, would there be any change in lime use?", 36.3 percent replied "no change", 43.3 percent said "some more", 15.9 percent said "much more", and 4.5 percent did not answer. Of interest is the fact that those farmers replying "much more" were already using more than the average amounts.

The study does indicate a major barrier to the movement of inputs and outputs to and from fields. While it may be unrealistic to expect all fields to border a road

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1/ Sung, Bai Yung, An Economic Analysis of Use of Agricultural Lime by Farmers, Department of Agricultural Economics, Seoul National University, May 1970, pp. 23-33.

passable by truck, an improved system of village to field roads would encourage the application of more lime. Conservatively, such improvement in feeder roads could result in a doubling in the application of lime.

What would be the payoff to doubling lime application, or even applying lime where no lime had been applied in the past? A recent study on rice and barley shows potential benefit-cost ratios of around 2:1 to 3:1. 1/ The discounted net return to lime application on single cropped rice paddy was about 80,000 won over a 5 year period at a 25 percent discount rate. Three metric tons of lime were applied in each of the 5 years. On barley, an annual application of 1.5 MT/ha. over 5 years gave a discounted net return of 42,400 won/ha. No tests were made on double cropped paddy but favorable BC ratios would be expected. 2/

For the nation as a whole, the application of lime is probably no more than a tenth of the current recommended levels. For most farmers the application of additional lime would be from a base of low level of lime application or none. In a village whose fields are accessible only on foot, assume that the total cultivated area is 50 hectares, of which 33 hectares are in paddy and 17 hectares are in upland. The discounted net return for applying 100 MT of lime per year for 5 years on the paddy land would be 2,640,000 won, using the analysis of Kim, Chung Ho. On the upland, assuming it is in barley, the payoff would be 720,000 won to the application of 25.5 MT of lime per year over 5 years. The total payoff to the village would be 3,360,000 won over 5 years.

Just as improved feeder roads will encourage higher levels of lime application, they will also bring about higher levels of fertilizer application on the more remote fields. Poor feeder roads are undoubtedly a major bottleneck to mechanization. Even those who now own power tillers

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1/ Kim, Chung Ho, "Economic Returns to Lime Applications on Rice and Barley," USAID, Rural Development Division, July 31, 1972.

2/ Ibid.

cite no roads or poor conditions of existing roads as a major problem associated with the utilization of power tillers. 1/ Specifically, this problem was listed in 13.4 percent of total responses. More frequently mentioned were "machine repair parts too expensive" (21.2 percent), "field not rearranged" (18.6 percent), and "repair station too far from farm" (15.7 percent).

For those villages with feeder roads incapable of handling power tillers, mechanization will be difficult. The Exotech study did not estimate the costs of improving feeder roads sufficiently to handle power tillers, but concluded that such costs would easily be covered by the benefits from mechanization. Using a 16 percent discount rate, Exotech calculated a benefit-cost ratio of 1.23 over a period from 1973 to 1997 for the mechanization of rice and barley crops in Korea. 2/

Adding the benefits from liming and mechanization alone, the benefit-cost ratios (4.42 and 2.83) at interest rates of 10 and 25 percent, respectively, calculated from cost savings in transportation could be at least doubled.

A 4 meter village to field road, rather than a 3 meter road, would add convenience, even though it would not be a necessity. The 4 meter road would allow ox carts to pass and also allow power tillers to pass. Such roads might well be built for the section of village to field roads most heavily traveled. If all the roads were this wide, the typical village with footpaths to fields would spend approximately 150,000 won to build 2.5 km. of such roads. The benefit-cost ratios would be around 2.5:1 at 10 percent interest, and 1.7:1 at 25 percent interest. Benefits from lime application and mechanization would be added.

Benefit-Costs on Village to Market Roads

We assumed the average distance from a farm or natural village to a local market was 3.5 km. However, the length

1/ Kim, Dong Hi, Survey by AERI, MAF

2/ Exotech Systems, Inc., op. cit., p. XIV. 17.

of feeder road required would be less; because, typically, the route to a market would follow a truck road at least part way. In fact, our calculations indicate the average distance to a truck road is 1 km., leaving 2.5 km. to travel on a truck road. Costs of transportation between farm and local market were based on the same mode being used for the entire trip. Even though a truck road was within a km., if the village was not accessible by truck, it is doubtful that the mode of transportation would be shifted to truck upon reaching a truck road. The same would apply to other modes.

Farm to market roads should be sufficiently wide to allow trucks to pass an ox cart. This would be at least 5 meters wide. Since most feeder roads are now 2.5 to 3.0 meters wide, this would involve widening the feeder road by 2 to 2.5 meters. As an average, assume the additional width is 2.5 meters. Using 200,000 won per meter of feeder road (land price at 200 won/pyong), the total cost would be 500,000 won per km. If land prices are 700 won/pyong, the total cost would be 917,500 won per km. Since the average distance to a truck road is 1 km., the total cost of a feeder road from the farm or village to a truck road would be 500,000 won to 917,500 won.

The total volume of product to be moved from farms to market and from input supply sources to farms in Korea is estimated to be about 9,917,000 MT in 1971, and 16,887,000 MT in 1981. Per village, this would be about 224 MT in 1971, and 382 MT in 1981. For villages accessible only by A-frame, substantial savings in transportation cost would be possible if ox carts could be used. Further saving would be realized by switching to power tiller. If a village has had good access by bicycle in the past, potential savings from a feeder road would be substantially less.

<u>Case 1: A-Frame to Ox Cart to Power Tiller</u>

Assume that the primary means of transportation is by A-frame. A feeder road of 1 km. to the nearest truck road is completed in 1972 at a cost of 500,000 won. In

1973, there is a complete shift to ox carts in transporting farm products to the market 3.5 km. away, and in transporting inputs back to the village. Between 1973 and 1981 there is a gradual shift from ox carts to power tillers as a means of transportation. Using the cost estimates in Table 11-2, a benefit-cost ratio of 15.1:1 is calculated at a 10 percent discount, and a ratio of 9.5:1 is calculated at a 25 percent discount rate. Even if the shift to power tillers was to only 50 percent by 1981, the benefit-cost ratios would be only slightly less, 14.8:1 and 9.4:1, respectively.

If 700 won/pyong has to be paid for land, the benefit-cost ratios are reduced to around 9.0:1 and 5.5:1, respectively.

Case 2: Bicycle to Ox Cart to Power Tiller

Assume that a village has a path to a truck road quite suitable for bicycle traffic. The conversion of this path to a feeder road passable by ox cart or power tiller would apparently not result in substantial savings in transportation cost relative to the investment. A benefit-cost ratio of 1.0:1 was calculated at 10 percent interest, and .5:1 at 25 percent interest, assuming land is priced at 200 won/pyong. At 700 won/pyong, the benefit-cost ratios are reduced to .6:1 and .3:1, respectively. If bicycle travel is difficult between the village and the truck road, benefit-cost ratios greater than one could easily result.

Case 3: A-Frame to Small Truck

Upon the completion of a feeder road to a village not accessible by truck, the small truck will undoubtedly play a more important role. This is true even though our costing figures indicate that potentially the power tiller could be a cheaper mode for short hauls. The small truck, however, has the flexibility of both short and longer hauls, and allows some specialization in performing the transportation function.

Assume that the conversion was made from A-frame to small truck the year after the feeder road was completed. For 1972-1981, the benefit-cost ratio would be 15.2:1 at a 10 percent discount, and 9.5:1 at a 25 percent discount, assuming 200 won/pyong was paid for the land. At a land price of 700 won/pyong, the benefit-cost ratios would be 9.2:1 and 5.6:1, respectively.

These and other alternative shifts in transportation modes could be examined. The general conclusion is that there would be a substantial payoff to constructing roads to link villages to truck roads in terms of saving in transportation costs alone. Other important benefits would also accrue to these investments. In most cases, the benefit-cost ratio would be higher in building feeder roads from villages to truck roads than from villages to fields.

National Situation

Some estimate can be made of the potential benefit-cost ratio for feeder roads between villages and truck roads for the nation as a whole. Based on a 1968 survey of rice marketing in Korea, estimates were made of the means of transportation to market and their relative importance. 1/ Another sample survey was made in 1971 of only those farms which produce 80 to 100 sok of rice per year. 2/ This is equivalent to 6 to 7 MT of rice, and would place these farmers in the size classification of "more than 2.0 hectares", i.e. the upper 10 percent of the farms by size.

From these studies the following table was developed, showing the relative importance of transportation modes at two points in time, and with respect to large farms versus the average (Table 11-3). The most notable

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1/ NACF-IMI, Joint Marketing Research Group Survey of Rice Marketing in Korea, February, 1969.

2/ Lee, Sang Cho, "Study on Rice Producers Marketing," World Food and Agriculture, Monthly Bulletin of Korea FAO Association, Vol.14, No.6, June 15, 1972, pp 17-24.

Table 11-3: Relative Importance of Modes of Transporting Rice in Korea 1/

Mode	Percent of Rice Sold by Farmer		Percent of Rice Sold and Transported by Farmer	
	1968 All Farms	1971 Large Farms	1968 All Farms	1971 Large Farms
A-Frame, on Head	7.2	-	8.0	-
Bicycle	3.2	-	3.6	-
Hand Cart	21.1	28.5	23.5	31.5
Ox Cart	54.0	29.6	60.2	32.7
Power Tiller	-	26.9	-	29.7
Taxi, Car, Bus	.1	.8	.1	.9
Small Truck	4.1	4.7	4.6	5.2
Total	(89.7)	(90.5)	100.0	100.0
Sold at Farm Gate	10.3	9.5		
Grand Total	100.0	100.0		

1/ NACF-IMI, Joint Marketing Research Group Survey of Rice Marketing in Korea, Seoul, Korea, 1969.

difference is the shift from ox cart to power tiller and the elimination of the A-frame and bicycle as a means of transporting rice.

If the data for the average farm in 1968 is somewhat representative of the average farm of today, and if the large farm of today is a preview of the average farm 5 years from now, some estimate of the prospective savings in transportation costs can be made. Using the percentages for all farms in 1968 as weights, and the costs of transportation from village to market given in Table 11-2, the weighted average cost was about 1,185 won/MT for 1972 (at both 10 percent and 25 percent interest rates). If the average farm in 1976 emulates the large farm of today, the weighted average cost of transportation to local markets would be 737 won/MT at 10 percent interest, and 751 won/MT at 25 percent interest. If the trend continues, and by 1981, 70 percent of the rice is transported by power tillers, 10 percent by small truck, and the balance by ox cart and hand cart, the weighted average cost would be reduced to 375 won at 10 percent, and 405 won at 25 percent interest.

Multiplying these savings by the total volume of products and inputs to be moved, the aggregate annual savings would be around 6 billion won in 1976, and 13.2 to 13.7 billion won by 1981. Such savings cannot be credited to feeder roads alone, but their improvement will accelerate this development. For the estimated 20 percent of Korean agricultural production in villages not accessible by truck, feeder roads will play a direct role. For an investment of approximately 9 to 16 billion won, some 17,000 to 18,000 km. of feeder roads could be constructed to link these villages to truck roads. The benefits solely from savings in transporting agricultural materials could be as much as 11 to 12 billion won annually within a few years just by converting from A-frame to ox carts. In making these estimates, no allowance has been made for the feeder roads constructed in 1971 and 1972.

Seasonal Demands on Transportation

As mentioned in Chapter 10, demands on transportation equipment are highly seasonal. This results in inefficiencies in the use of transportation equipment and forces premiums to be paid to shippers at certain times of the year.

The seasonal pattern on farm sales of grain and pulses is indicated in Table 11-4. The pattern for 1971 and projected to 1981 for each province was calculated from the national sales estimates for each crop in the Farm Household Economy Survey. The average monthly sales pattern for 1967-1970 was assumed. The peak sales in December have been more than double the rate for most of the other months. The expansion of barley production relative to rice between now and 1981 will result in a less pronounced peak in Decmeber but the wide seasonal

Table 11-4: Total Sales of Grains and Pulses from Farms, Korea, 1971 and Projected to 1981

Region and Province	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1971											
	1,000 MT											
Single Paddy												
Kyenggi Do	38	27	26	19	18	15	11	10	13	25	53	78
Chungcheon Nam Do	37	25	25	18	17	14	10	10	12	24	51	74
Double Paddy												
Jeolla Bug Do	35	25	26	18	19	26	32	21	19	25	48	68
Jeolla Nam Do	30	22	25	18	20	49	74	43	30	26	40	55
Gyeongsang Bug Do	38	27	29	21	21	35	46	29	24	29	53	75
Gyeongsang Nam Do	29	22	24	17	18	37	53	32	24	24	40	55
Upland												
Ganweon Do	7	5	5	4	4	3	3	3	2	5	12	16
Chungcheon Bug Do	9	7	6	4	4	6	6	4	4	7	14	19
Jeju	1	1	1	1	1	2	3	2	1	1	2	2
Total	224	161	167	120	122	187	238	154	129	166	313	442
	1981											
Single Paddy												
Kyenggi Do	60	42	42	30	29	29	26	21	23	41	83	120
Chungcheon Nam Do	70	49	51	37	38	55	67	44	38	52	97	137
Double Paddy												
Jeolla Bug Do	62	45	47	33	35	58	76	47	39	48	85	121
Jeolla Nam Do	59	45	50	36	41	94	139	81	58	53	86	111
Gyeongsang Bug Do	69	50	54	39	42	77	106	64	50	56	97	134
Gyeongsang Nam Do	51	38	42	30	33	71	103	60	45	44	70	97
Upland												
Ganweon Do	10	6	6	6	5	6	5	4	4	6	15	21
Chungcheon Bug Do	28	21	22	16	16	27	35	22	18	23	41	57
Jeju	1	1	1	1	1	1	1	1	1	1	1	1
Total	410	297	315	228	240	418	558	344	276	324	575	799

swings in sales will remain unless more on-farm (or in village) storage is encouraged.

Vegetables, potatoes, and fruit represent the bulk of other crops sold from Korean farms. Adding these crops to grains and pulses, the seasonal sales pattern for all crops was calculated (Table 11-5). The peak in sales of vegetables, potatoes and fruit is also in the fall but earlier than for grain and pulses (Table 11-6). This places the peak in sales of all crops in November. This peak has been at least double the rate of sales in other months except October and December. The seasonal variation has been somewhat more extreme in the single paddy provinces than in the double paddy provinces.

To ease the pressure on transportation facilities, some means of reducing farm sales in November and December would appear well worth exploring. More local storage of grain and pulses would be one way. New varieties of summer grain crops that would allow expansion of the double cropping area would also help to even out the flow of products to market over the year. Use of polyethelene for expanding winter vegetable production would be another means for shifting production to slack periods. These alternatives for a more even flow of products to market would not only foster more efficient use of transportation facilities, but would also make more intensive use of farm resources and even out the highly seasonal pattern in farm labor requirements.

Table 11-5: Total Sales of Crops from Farms, Korea, 1971 and Projected to 1981

Region and Province	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1971											
	1,000 MT											
Single Paddy												
Kyenggi Do	56	43	42	46	46	46	42	55	56	83	129	126
Chungcheon Nam Do	47	33	33	30	21	26	25	33	42	50	85	94
Double Paddy												
Jeolla Bug Do	43	33	42	40	32	36	43	32	31	44	84	83
Jeolla Nam Do	40	32	45	44	38	64	87	58	46	52	88	77
Gyeongsang Bug Do	58	44	46	36	36	48	62	52	55	72	98	108
Gyeongsang Nam Do	47	39	39	48	50	68	82	69	56	83	124	102
Upland												
Ganweon Do	14	11	13	15	14	13	12	14	14	25	41	33
Chungcheon Bug Do	16	13	17	12	12	13	14	15	16	24	37	32
Jeju	6	6	12	14	8	6	9	6	6	9	20	10
Total	327	254	289	285	257	320	376	334	322	442	706	665
	1981											
Single Paddy												
Kyenggi Do	91	69	71	69	76	81	80	102	99	138	210	198
Chungcheon Nam Do	92	68	76	67	64	80	101	94	84	109	171	182
Double Paddy												
Jeolla Bug Do	79	64	85	79	63	80	101	74	66	90	164	156
Jeolla Nam Do	81	68	96	92	78	124	168	115	95	108	183	158
Gyeongsang Bug Do	111	88	90	78	73	103	138	111	113	143	194	204
Gyeongsang Nam Do	83	68	91	89	87	123	155	125	111	144	217	175
Upland												
Ganweon Do	22	18	26	31	24	23	21	23	26	40	69	48
Chungcheon Bug Do	46	38	41	46	38	45	57	50	48	67	102	91
Jeju	12	13	29	33	15	9	11	9	10	16	44	18
Total	617	494	605	584	518	668	832	703	652	855	1354	1230

Table 11-6: Seasonal Pattern of Sales From Farms, Korea, Average for 1967-70

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot.
Rice 1/	11.8	8.0	8.1	5.6	5.4	4.4	3.2	2.9	3.9	7.5	15.8	23.4	100
Barley and Wheat 1/	2.4	2.7	4.0	2.9	4.2	17.3	29.0	15.7	9.7	5.2	3.7	3.2	100
Other Grain 1/	11.9	5.8	5.6	6.5	4.8	6.5	5.2	4.8	3.8	3.8	17.2	2.4	100
Pulses 1/	9.2	7.0	6.5	6.3	5.6	5.9	3.9	3.7	3.8	8.9	17.4	21.8	100
Vegetables 2/	4.0	3.4	3.7	4.8	7.4	8.2	6.7	8.0	8.3	14.4	19.1	12.0	100
Potatoes 1/	4.3	5.4	13.8	16.7	7.4	3.9	4.5	4.3	4.8	7.6	20.7	6.6	100
Fruit													
Apples 2/	11.7	10.0	5.7	5.7	3.8	.6	1.3	3.8	13.9	15.2	12.7	15.8	100
Pears 2/	11.2	7.0	2.9	3.3	1.8	.4	-	2.6	34.8	18.1	10.1	7.8	100
Persimmons 2/	1.6	.8	-	-	-	-	-	.6	27.2	42.2	22.6	5.0	100
Grapes 2/	-	-	-	-	-	-	2.6	68.5	28.9	-	-	-	100
Peaches 2/	-	-	-	-	-	7.3	42.9	44.4	5.4	-	-	-	100
Citrus 3/	30.0	25.0	10.0	-	-	-	-	-	-	-	10.0	25.0	100

1/ Based on "sales in the broad sense" from the Farm Household Economy Survey of MAF for 1967-70

2/ Estimated from urban purchases in 1967-69 as estimated by NACF.

3/ Estimated.

Part III

APPENDICES

Appendix I

Procedures for Estimating and Projecting Monthly Sales, Consumption and Storage-Transportation Requirements by Province

The KASS simulation model and data from the Ministry of Agriculture and Forestry provided the information necessary to estimate and to project monthly sales, consumption and storage-transportation requirements by province. The KASS simulation model generated projections for each year from 1971 to 1985 under Alternative IV of the Korean Agricultural Sector Analysis, assuming an intensive family planning program. 1/ Two years were selected for special study, 1971 serving as the base year and 1981 as a target projection year.

The KASS simulation model is designed to project production of major crops by three regions and livestock production for the nation as a whole. The regions were single paddy (Kyenggi Do, Chungcheon Nam Do), double paddy (Jeolla Nam Do, Jeolla Bug Do, Gyeongsang Bug Do, Gyeongsang Nam Do) and upland (Ganweon Do, Chungcheon Bug Do, Jeju). The model also projects per capita farm consumption by regions and per capita nonfarm consumption for the nation as a whole. Farm population by region and total nonfarm population were also projected.

In order to obtain production estimates for provinces, the average production in each province for 1966-70 was compared with the average for the same years in the respective regions. The projections for provinces were then derived by assuming that each province maintained the same proportion of the regional production as in 1966-70. An inspection of the data on major crops for 1960 through 1970 revealed only minor shifts among the provinces in each region.

1/ Rossmiller, et. al., Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, AERI, MAF, Seoul, Korea and Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1972

Some attempt was made to estimate per capita consumption by province, but with little success. Only minor differentiation was made by the KASS simulation model between regions in estimating per capita farm consumption. The Farm Household Economy Survey of MAF is designed only for national estimates at present. Being planned is an expansion of this survey which will allow estimates by provinces. For lack of data, the assumption was made that per capita farm consumption in each province would be the same as in the respective region.

Nonfarm per capita consumption was assumed to be the same throughout the nation. Some differences by area are indicated by the government s survey of key cities, but their estimates were felt to be unsatisfactory to represent different provinces.

Estimates of nonfarm population were available for 1969 by provinces, and were used in combination with 1971 per capita consumption to calculate nonfarm consumption by provinces. Similarly, 1969 farm population statistics were used to obtain estimates of farm consumption for 1971. For 1981, nonfarm consumption was assumed to be distributed among the provinces in the same proportion as population projected by OTAM-Metra International. 1/ Similarly, the allocation of farm consumption in each region to the component provinces was based on population projections in the OTAM-Metra study. The computations are shown in Table AI-1.

To estimate monthly sales, consumption, and storage-transportation requirements by province, monthly sales and monthly per capita consumption data were obtained for 1967-70 from the Farm Household Economy Survey of MAF for major crops. Per capita purchases in urban areas on major crops by months were obtained for 1967-69 from NACF. 2/ Using

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1/ OTAM-Metra International, Population and Employment, Regional Physical Planning, Vol. 4, Report prepared for the UN, Seoul, June, 1971.

2/ NACF, A Report on the Status of Agricultural Products Purchased by Urban Households, Volumes for 1968, 1969, and 1970, Korea.

Table AI-1: Estimated Nonfarm and Farm Population by Province, 1969 and 1981, Assuming Intensive Family Planning

	1969			1981		
	Nonfarm 1,000	Farm 1,000	Total 1,000	Nonfarm 1,000	Farm 1,000	Total 1,000
Single Paddy					2,688	
Kyenggi Do	7,263	1,631	8,894	11,580	1,396	12,976
Chungcheon Nam Do	863	1,998	2,861	1,329	1,288	2,617
Double Paddy					7,674	
Jeolla Bug Do	663	1,772	2,435	844	1,212	2,056
Jeolla Nam Do	1,053	2,953	4,006	1,789	2,310	4,099
Gyeongsang Bug Do	1,879	2,681	4,560	3,067	2,187	5,254
Gyeongsang Nam Do	2,736	2,264	5,027	5,240	1,965	7,205
Upland						
Ganweon Do	955	912	1,867	1,304	1,003	2,307
Chungcheon Bug Do	376	1,108	1,482	256	476	732
Jeju	94	272	366	153	351	504
Total	15,882	15,589	31,498	25,560	12,190	27,750

Source: Based on projections from the KASS simulation model and OTAM-Metra International's Population and Employment, op. cit.

these data, seasonal patterns on sales, farm consumption, and urban purchases were derived for the nation as a whole. These patterns were assumed to be the same for each province for grain and pulses and were further assumed to be the same in 1981 as in 1971.

To estimate farm sales by month by province, the estimated production was first adjusted downward by a factor representing a combination of loss on farms, seed use, feed use, and statistical discrepancy. From this adjusted production figure was deducted an estimate of farm consumption (human). The balance, then, represented the amount available for sale during the year. This balance was then multiplied by the percent of sales by months based on the average for 1967-70. 1/ These monthly percentages on grains pulses, and potatoes represent sales "in the broad sense;" that is, both sales for cash in the market and sales and payments in kind. For vegetables and fruit, monthly sales were derived from estimates of monthly purchases by urban consumers.

To estimate farm consumption by province by months, estimates of annual farm consumption (farm population times per capita farm consumption) were multiplied by the percent of annual per capita consumption on farms by months.

Another estimate made was the amount stored on farms by province by month. This was obtained by taking the provincial production (unadjusted) and subtracting monthly sales and monthly farm consumption beginning with the first month of harvest. By cumulating the deduction for sales and for farm consumption, the residual is the amount remaining on farms. No attempt was made to allocate losses, food uses, or statistical discrepancies to months. In provinces in which adjusted farm production was less than farm consumption, storage on farms was estimated to be equal to production less accumulated farm consumption for each month from harvest until the production was consumed; thereafter, storage levels were considered to be nil.

1/ If the balance was negative, farm sales were entered as zero for each month after harvest until on-farm consumption accumulated to the adjusted production level. Thereafter, farm sales became the negative of on farm consumption.

Also estimated were the monthly additions to the surplus or deficits by province. The computation was simply farm sales less nonfarm consumption. Nonfarm consumption on grains was considered to be a constant each month, as indicated by the NACF data on urban purchases. For pulses, potatoes, vegetables, and fruit, however, a seasonal pattern was calculated based on urban purchases in 1967-69.

Beginning with the first month of harvest, the additions to surplus or deficits were cumulated to indicate the total non-farm storage or transportation requirements by province as would develop over the year. The positive figures represent the amounts which would accumulate through the year if the product were not shipped out of the province. In a sense, this could be considered demands upon storage and for transportation facilities. By the end of the crop year, the balance remaining would represent what must be shipped out of the province if inventories were not allowed to increase from crop year to crop year. Within the crop year the amounts would represent conceivable peak loads on storage facilities.

The negative numbers would represent the summation of the amounts from the beginning of the crop year which much be shipped into the province. At the end of the crop year, the sum would equal the annual inshipment requirement.

For vegetables, no storage estimates were made since the storage function is primarily handled by the consumer. For fruit, a separate estimate was made of the pattern of sales in each province since there is a considerable difference in the composition of fruit production from one province to another. This pattern was estimated by calculating the percent that apple, pear, persimmon, grape, and peach production represented of the total of these fruits in each province for 1968-70. A seasonal pattern of sales was calculated for each of these fruits from the estimates of monthly purchases by urban families. These percentages of sales by month then were multiplied by the respective weights for each fruit by province. Summing these figures for the five fruits for each province provided a rough estimate of the seasonal pattern of fruit sales for each province. Jeju was handled separately since oranges are the predominant fruit.

While some seasonality in livestock production exists and some storage occurs, no attempt was made to derive such estimates. Also, no estimates were made by province considering the difficulty of forecasting the location of livestock production, particularly intensive units.

Appendix II

Distances Products Travel

To assess the total demand for transportation service, some estimates must be made of both the volume handled and the distances such products must be moved. An arbitrary division was made in the destination points for farm products into (1) first receiver, including the local mill, an assembly point, nearest road, or local market, (2) the nonfarm consumer within the same province, and (3) the nonfarm consumer in an outside province. Included under (1) is the movement to and from the mill for home consumption on the farm.

No specific estimates are available on the distances involved in these movements by province, although some indications may be derived from several research studies. A comprehensive study of rural road development by Park, Jin Hwan provides a basis for calculating these distances. A study of 368 villages in Hwasung Gun, Kyenggi Do Province in 1968 indicated the average distance of farm to myun roads to be about .9 km. as indicated in Table AII-1.1/

A study of 79 villages in Yangpyung Gun, Kyenggi Do Province, which do not permit truck traffic, indicated an average length of 1.24 km. of access road per village. One out of three villages needed a bridge on the access road. The longer length of road in Yangpyung Gun is due to the fact that this gun is in a mountainous area, while the Hwasung Gun is mostly in a plain area.

The survey by Park, Jin Hwan covered the entire nation and from the sample of 32,150 villages, he found that 31 percent were inaccessible by trucks and another 9 percent would permit a truck to enter but would not allow the truck to turn around. On the basis of the number of farm households, 22.2 percent were inaccessible by truck and 7.3 percent could receive trucks but could not allow them to turn around.

1/ Park, Jin Hwan, "Problems and Policy Program in Agricultural Sector Third Plan Period," Unpublished Report, Seoul, 1970.

Table AII-1: Distance From Myun Road to Village, 368 Villages in Hwasung Gun, Kyenggi Do Province, 1968

Distance From Myun Road to Village	Number of Villages	Total Number Of Farm Households	Number of Farm Households per Village
Meters			
Neighboring to Road	68	3656	54
Less than 200	47	2911	62
200 - 500	62	3754	61
500 - 1000	65	3121	48
1000 - 1500	33	1725	52
1500 - 2000	33	1839	56
2000 - 3000	31	1772	57
3000 - 4000	16	831	52
4000 - 5000	4	140	35
More than 5000	9	408	45
Total	368	20,157	55

A detailed study of a sample of 17 villages in Hwasung Gun, Kyenggi Do Province classified the villages into "foot path", "cart road", "truck road", and "bus route." 1/ The foot paths averaged about 1 km. and the cart roads also averaged about 1 km. to a bus route. Of the 9 foot-path and cart road villages studied, 5 required travel on "good weather" truck roads ranging from 1 to 5 km. in length. The truck road villages also required travel of about 1 to 5 km. to reach a bus route. The distance by bus for most of the villages was between 25 and 45 km.

1/ Kim, Chung Ho, Influence of Road Class and Means of Transportation on Farm Enterprise Distribution, Hwasung Gun, Kyenggi Do Province, Republic of Korea, USAID in cooperation with AERI, MAF, Sept. 1970.

A study was made of two villages in Ganweon Do Province in an upland area for comparison purposes, one on a national highway, and the other 7 km. away on a poor secondary road. 1/ There were 324 farmers in the first village and 158 farmers in the second. A regular bus line passes through the village on the national highway, so the farmers purchase inputs for farming and certain necessities of life in markets in Kangnung located 16 km. west of the village. Of the farmers surveyed, each made about 10 trips to Kangnung in an eight month period, 2-3 times on farming business. In contrast, the farmers on the poor road made only about 3 trips in an eight month period, one of which was on farming business. Among the 50 farmers surveyed in the village on the highway, a total of 66 trips had been taken to Seoul 140 miles away, of which 39 trips were to sell products. In the isolated village only 6 such trips were recorded among the 50 farmers.

A study of fifteen representative villages in the Honam area found the average distance from a farm to a main city market station to be 38 km.; to a county or district market, 11.3 km.; and to a bus road, 2.4 km. 2/ All of the cash crop growing villages in the survey were centered around railroad stations.

A survey of rice marketing in Korea revealed that most farmers are within 8 km. of a market. 3/ An estimated mean distance weighted by rice sales was about 3.5 km. Of 3422 bags of rice sold through various outlets, 32 percent were from farmers within 2 km. of a market, 34

1/ Lee, Kyung Won, Some Effects of Roads on Agricultural Production and Rural Life, Department of Agricultural Economics, Seoul National University, May, 1969.

2/ Kim, Sung Hoon, "Effects of Farm Level Marketing and Credit Services on Commercialization of Subsistence Agriculture in Korea," Proceedings of the Inter-Regional Workshop on Agricultural Marketing, August 27 - September 5, 1969, Taipei, Joint Commission on Rural Reconstruction.

3/ NACF-IMI Joint Marketing Research Group, Survey of Rice Marketing In Korea, February, 1969.

percent were 2-4 km. from a market, 32 percent were 4-8 km., and about 15 percent of the sales were from farms more than 8 km. from a market.

A report on construction of feeder roads in Chonup Gun in Jeolla Bug Do Province indicated an average length of about one-half a km. Since this gun is located in a relatively level area, length of feeder roads would be expected to be less than average. Other villages visited in Jeolla Bug Do and Jeolla Nam Do Provinces also indicated feeder roads to be less than one km. in length.

Another way to obtain some idea of distances between farmers and their markets or trading centers is to look at the square km. of cultivated land per myun. If one assumes that the myun represents the standard rural trading area of the coming one and one-half decades, and that the natural villages are scattered with a fairly even distribution over the cultivated area with the trading center tending to be centrally located, then some crude estimates can be made of the average distance for agricultural products to travel to the country market. Table AII-2 indicates that the area per myun is close to 17 square km. This would make the average distance to the center of the myun about 3 km. "as the crow flies". A reasonable estimate of actual travel distance would perhaps be more like 4 km. Distance to the nearest 5-day market may be similar since there is about one 5-day market per myun.

As a rough estimate of distance to a major trading center, the area of cultivated land per city over 50,000 persons is 566 square km. (Table AII-2). This would indicate maximum travel of about 20 to 25 km. to reach such a city, with 15 km. being about average. There would be considerable difference in these distances depending on the province.

The adequacy of car roads in the various provinces is indicated by the km. of provincial, city, and gun roads per square km. of cultivated land (Table AII-2). The ratio of roads to cultivated area was just over one and much less than in Japan and Taiwan.

A representative myun in rural Korea based on the foregoing information would consist of about 30 natural villages located an average of about 1 km. from a truck road. Most villages would be within 2 to 3 km. of a truck road. About

Table AII-2: Area of Cultivated Land Relative to Cities, Myun and Road Lengths

	Area of Cultivated Land Sq. km.	Number of Cities of 50,000 and Over, 1970	Area of Cultivated Land per City Sq. km.	Number of Myuns, 1970	Area of Cultivated Land Per Myun	Total Provincial City and Gun Roads, Jan. 1, 1971, 1000 km.	Ratio of Roads to Cultivated Land
Single Paddy							
Kyenggi Do	3189	9	354	185	17.2	3450	1.082
Chungcheon Nam Do	2976	2	1488	164	18.1	2595	.872
Double Paddy							
Jeolla Bug Do	2594	3	864	155	16.7	2728	1.052
Jeolla Nam Do	3846	4	961	215	17.9	4121	1.072
Gyeongsang Bug Do	3930	7	561	237	16.6	4076	1.037
Gyeongsang Nam Do	3216	7	459	215	15.0	3588	1.116
Upland							
Ganweon Do	1704	6	284	95	15.0	2043	1.202
Chungcheon Bug Do	1806	3	602	99	18.2	1855	1.027
Jeju	500	1	600	10	50.0	1630	3.260
Total or Average	23,761	42	566	1375	17.28	26,091	1.098

3-4 km. would be traveled to reach a 5-day market or local trading center, and about 15 km. to reach a city market. About 30 percent of the villages would not be accessible by truck. Such villages would represent about 22 percent of the households.

While data are lacking on the condition of feeder roads, some information is available concerning provincial, city, and gun roads (Table AII-3). From these estimates, it would appear that approximately 97 percent of the distance traveled within a province would be on an unpaved or unrepaired truck road.

As a basis for calculating some benefits which would accrue to constructing new feeder roads (or widening them), and to paving provincial, gun, and city roads, some estimates were made of the volume of product to be moved from farms and the distances traveled over such roads. Villages were assumed to be an average of 1 km. from a truck road, and about 20 percent of total agricultural production is assumed to be in villages presently not accessible by truck. Products sold from farms and consumed within the same province would likely travel almost entirely on an unpaved road to reach its destination. The average distance a product would travel to consumers within the province would be about 20 km. About 95 percent would be over unpaved roads.

A similar distance is assumed from the farm to a paved truck road or rail terminal for products destined for markets outside the province -- about 20 km. Because the system of paved highways in Korea will be soon extended to major cities and producing area, the assumption was also made that once farm products reached a paved highway, they would continue on paved highways, rail, or waterway until reaching the destination.

Farm Fields to Farm Households

Since farm households are predominantly in villages, farmers must travel some distance to reach their fields. Just how far has not been estimated in available research studies. Consider that an average village of over 10 households cultivates about 50 hectares equivalent to an

Table AII-3: Status of Road Construction, Jan.1, 1971

Province	Condition of Provincial, City, and Gun Roads			
	Paved	Unpaved or Unrepaired	Total	Percent Unpaved or Unrepaired
		1,000 km.		Percent
Single Paddy				
Kyenggi Do	187	3263	3450	94.6
Chungcheon Nam Do	33	2562	2595	98.7
Double Paddy				
Jeolla Bug Do	54	2674	2728	98.0
Jeolla Nam Do	64	4057	4121	98.4
Gyeongsang Bug Do	164	3912	4076	96.0
Gyeongsang Nam Do	.84	3504	3588	97.6
Upland				
Ganweon Do	22	2026	2048	98.9
Chungcheon Bug Do	35	1820	1855	98.1
Jeju	35	1595	1630	97.8
Total	678	25,413	26,091	97.4

area about .7 km. by .7 km. If the village is centrally located within the cultivated area, farm products and inputs would have to be transported an average of two-thirds km. between the fields and the village. The total length of field to farm roads serving such an area is estimated to be about 2.5 km. This would allow each farmer to reach his field, or at least allow him to drive the power tiller to the field. Obviously, this length of feeder road will vary from village to village. The more heavily traveled sections should be wider than the extremities. Care should be taken not to remove any more highly valued paddy land out of production than absolutely necessary. The foregone production could easily offset any extra convenience from a road which is wider than necessary for a power tiller -- at least at the extreme sections of a village to field feeder road network.

Appendix III

Costs of Feeder Road Construction

A total of 7167 kilometers of feeder road were constructed in 1970. Construction and costs by province are shown in Table AIII-1.

Table AIII-1: Feeder Road Construction Costs 1970

Province	Total Cost (000 W)	Construction km.	Cost/km. (Won)
Kyenggi Do	189,388	396	478,253
Ganweon Do	209,425	344	608,790
Chungcheon Bug Do	264,255	653	404,678
Chungcheon Nam Do	397,358	1,298	306,131
Jeolla Bug Do	364,050	818	445,048
Jeolla Nam Do	445,475	1,100	404,977
Gyeongsang Bug Do	604,350	1,496	403,977
Gyeongsang Nam Do	289,770	689	419,695
Jeju	90,000	373	241,286
Total	2,853,471	7,167	398,140

Source: Derived from Ministry of Home Affairs, Status of Feeder Road Development, 1971.

Overall average costs were approximately 400,000 won per km., ranging from over 600,000 won per km. in mountainous Ganweon Do Province to 240,000 won per km. on Jeju.

Of the 2.8 billion won total for feeder road construction in 1970, 817 million won (29 percent) was for actual construction material, 752 million won (26 percent) for land purchase, 1.2 billion won (42 percent) for labor, and 87 million won (3 percent) for survey.

Construction Materials Cost

Costs of materials by province for 1970 are indicated in Table AIII-2.

Table AIII-2: Structural Costs - Feeder Roads, 1970

Province	Cost of Structure (000 W)	km.	Structural Cost per km.
Kyenggi Do	69,617	396	175,800
Ganweon Do	65,513	344	190,445
Chungcheon Bug Do	89,196	653	136,594
Chungcheon Nam Do	109,895	1,298	84,665
Jeolla Bug Do	96,840	818	118,386
Jeolla Nam Do	120,276	1,180	109,342
Gyeongsang Bug Do	163,163	1,496	109,066
Gyeongsang Nam Do	78,004	689	113,300
Jeju	24,300	373	65,147
Total	816,864	7,167	113,976

Average structural cost nationwide is 114,000 won per km., with range from 190,000 won to 65,000 won. Included in this category is cost of cement, gravel, and culverts.

Data collected by United Nations Development Program on feeder roads constructed in 1971-72 as part of a comprehensive development program indicate a range of structural costs of 192,692 won per km. to 580,000 won per km. These totals include operation of heavy earth moving equipment seldom, if ever, used in feeder road construction; but detailed cost breakdown does help suggest cost of contracting road construction. No labor or land costs were included in the totals.

Government contribution on feeder roads is limited to costs of these structural materials. Land and labor are provided by the rural populace. In 1970, the central government actually paid 47.6 percent of the total 817 million won, or 389,521,000 won. Provincial governments paid a total of 188 million won, 23 percent of the total cost of materials, and city and county governments paid the remaining portion including survey and design costs.

Labor

Labor costs are difficult to estimate since there is surplus labor available in farming areas at certain time of the year. Rural feeder road construction may essentially draw on the slack labor supply for which the opportunity cost is zero or very low. Labor costs recorded as part of the 1970 feeder road construction costs are shown in Table AIII-3.

These gross figures say little about the actual labor input per km. of road construction. At the 1970 farm wage rate (580 won per man day), man day inputs per km. of feeder road may be calculated. Alternatively man day inputs per km. may be estimated from other sources and applied to total costs to arrive at an estimated wage rate. Wage rates shown in column 5 of Table AIII-4 are calculated using 400 man days per km. as the mean, 1/ and adjusting the man day figure for each province to reflect variable construction conditions in different parts of the country. The variability is evident from column 3 of Table AIII-4 where a constant wage rate was used. The resulting lower wage rates are likely closer to the opportunity cost of rural labor than the 580 won per man day national rate in 1970, though the national rate suggests the upper limit. Man days per km. on Jeju are assumed to be 400, the average. Wages are generally lower there than in other provinces, but construction time required to build a km. of feeder road should not vary substantially.

Land Costs

The other major cost component is land. As noted, land is "contributed" by rural people for road construction.

1/ Based on surveys conducted in rural villages in Jeolla Nam Do and Jeolla Bug Do Provinces, August, 1972.

Table AIII-3: Labor Costs Feeder Road Construction, 1970

Province	Total Labor Cost (000 W)	km.	Labor Cost Per km.
Kyenggi Do	70,555	396	178,169
Ganweon Do 1/	84,775	344	246,439
Chungcheon Bug Do	103,428	653	158,388
Chungcheon Nam Do	168,332	1,298	130,456
Jeolla Bug Do	158,000	818	193,154
Jeolla Nam Do	191,551	1,100	174,143
Gyeongsang Bug Do	259,883	1,496	173,719
Gyeongsang Nam Do	124,355	689	180,486
Jeju	38,700	373	103,753
Total	1,200,585	7,167	167,515

1/ Again, labor costs per km. are highest in Ganweon Do Province.

Source: Based on surveys conducted in rural villages in Jeolla Nam Do and Jeolla Bug Do Provinces, August, 1972.

Table AIII-4: Estimated Labor Inputs for Feeder Road Construction - 1970

Province	Labor Cost Per km. (W)	Man Day Per km. @ 580 W/Day	Adjusted Man Days (Ave. 400)	Wage Rate/ Day At Esti- mated Man Day
Kyenggi Do	178,169	307	408	437
Ganweon Do	246,439	425	516	478
Chungcheon Bug Do	158,388	273	364	435
Chungcheon Nam Do	130,456	225	316	413
Jeolla Bug Do	193,154	333	424	456
Jeolla Nam Do	174,143	300	391	445
Gyeongsang Bug Do	173,719	300	391	444
Gyeongsang Nam Do	180,486	311	402	449
Jeju	103,753	179	400	259
Average	167,515	309 1/	400	453

1/ Excluding Jeju

there is no compensation involved, and the cost burden is certainly not borne uniformly. Only those land owners in the path of construction experience direct loss, while benefits of construction are widely dispersed.

Average cost per pyong was approximately 105 won in 1970, apparently a low price even for that year. (See Table AIII-5) In a recent survey of rural villages, land costs were estimated at 500-700 won per pyong. At that rate, average cost of land for road construction per km. based on the 1970 construction figures would be 500,000 to 750,000 won.

Data on costs of constructing small concrete bridges for the feeder road system were collected in village interviews. Costs from two of the villages are summarized in Table AIII-6. Presumably, costs of constructing necessary bridges are included in the cost totals for feeder road construction.

Future Construction

Construction plans for feeder roads after 1972 indicate an average costs of 471,839 won per km. with a considerable range by type of road. (See Table AIII-7.) Part of the price range for feeder road construction after 1972 is accounted for by the fact that some roads are being built as new roads, while others are only being improved or widened. In virtually all cases there is some form of route or path to be improved to a minimum quality for vehicle traffic. There is no clear distinction between roads to be widened and roads to be built new -- all seem to require improvement, some more than others. Table AIII-8 indicates the option of needed feeder road construction which is actually labeled as widening of existing roads. Breakdown within each type of feeder road is suggested in Table AIII-9. Roads connecting villages to farm fields are most apt to involve relatively new construction, or at least the greatest degree of improvement.

Table AIII-5: Land Costs - Feeder Road Construction
1970

Province	Total Land Cost (000 W)	Con-structed km.	Land Cost Per km. of Road (W)	Estimated Cost Per Pyong 5 m. Pd. 1/
Kyenggi Do	44,295	396	111,856	112
Ganweon Do	53,223	344	154,718	155
Chungcheon Bug Do	64,468	653	98,726	99
Chungcheon Nam Do	106,318	1,298	81,909	82
Jeolla Bug Do	98,290	818	120,159	120
Jeolla Nam Do	120,278	1,100	109,344	109
Gyeongsang Bug Do	163,174	1,496	113,318	109
Gyeongsang Nam Do	78,076	689	113,318	113
Jeju	24,300	373	65,147	65
Total	752,422	7,167	104,984	105

1/ One km. of new 5 meter road requires 1,500 pyong of land area. Improvement of a road from 2.5 to 5 meters would require 750 pyong per km. Since few roads are entirely new, 1,000 pyong per km. is used in this column.

Table AIII-6: Costs of Construction of Small Concrete Bridges in Two Villages

	Village 1 1/		Village 2 2/	
	W	W/m^2	W	W/m^2
Labor	35,000	2,333	168,000	6,000
Materials	72,800	4,853	100,000	3,589
Other	3,000	200	36,000	1,286
Total	110,800	7,381	304,000	10,875

1/ Taebong-ri, Muan Gun, Jeolla Nam Province. The bridge was 3 meters wide, 5 meters long. Labor was calculated as 50 person days at 700 won per day. Materials included cement (60 bags at 430 won) and iron bars (10 meters/t. at 4,700 won).

2/ Sukwha-ri, Chungwon Gun, Chungcheon Bug Province. The bridge was 2.8 meters by 10 meters. Four times as much labor was used as in Village 1 (210 persons at 800 won). Cement was 200 bags at 390 won and iron bars 5 meters/t. at 4,500 won. Wooden forms were used, wood cost 20 pyong at 1,800 won.

Table AIII-7: Planned Feeder Road Costs by Type 1/
(1972 - 1976)

Cost Range (000 W)	Type A km.	Type A Ave. Cost Per km. (000 W)	Type B km.	Type B Ave. Cost Per km. (000 W)	Type C km.	Type C Ave. Cost Per km. (000 W)	Total km.	Total Ave. Cost Per km. (000 W)
- 300	2,460	213	1,785	188	2,493	198	6,738	201
300 - 500	1,724	385	1,466	386	1,726	399	4,916	390
500 - 1000	2,070	663	1,323	623	1,934	638	5,326	644
- 1000	789	1,113	516	1,160	781	1,029	2,086	1,100
Total	7,043	490	5,091	456	6,934	464	19,066	472

1/ Type A - National village to local road
Type B - National village to farm land
Type C - National village to natural village

Table AIII-8: Feeder Road Construction 1972-1976, Proportions New and Improved

Province	Total to be Constructed (km.)	New Roads	Percent	Widened Roads	Percent
Kyenggi Do	1,458	213	15	1,245	85
Ganweon Do	1,270	694	55	576	45
Chungcheon Bug Do	1,702	798	46	913	54
Chungcheon Nam Do	1,974	968	59	1,006	51
Jeolla Bug Do	1,278	485	37	793	62
Jeolla Nam Do	3,448	2,036	59	1,412	41
Gyeongsang Bug Do	2,936	1,100	37	1,836	63
Gyeongsang Nam Do	3,712	2,237	60	1,477	40
Jeju	1,286	138	11	1,148	89
Total	19,066	8,660	45	10,406	55

Source: Ministry of Home Affairs, "Construction of Feeder Roads, 1972."

Table AIII-9: Proportion of Feeder Road Construction to be New Road, by Type, 1972-1976

Province	Type A	Type B	Type C
	%	%	%
Kyenggi Do	1	19	15
Gangweon Do	63	54	47
Chungcheon Bug Do	45	61	42
Chungcheon Nam Do	44	54	52
Jeolla Bug Do	34	36	42
Jeolla Nam Do	51	66	59
Gyeongsang Bug Do	34	48	36
Gyeongsang Nam Do	50	73	57
Jeju	19	89	6
Average	42	52	43

Part IV

AGRICULTURAL RESEARCH

Glenn L. Johnson
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Chapter 12

An Investment in Support of Agricultural Research

The Korean Agricultural Sector Study (KASS) has identified Korea's inadequate biological technology as one of the most important long run constraints on development of Korean agriculture. More specifically, the deficiencies were noted to be with respect to rice, other food grains, soybeans, feed grains and forages (both perennials for uplands and annuals for fuller utilization of idle winter paddies). Higher yields and shorter growing periods are needed for the grains. Shorter growing periods for grains and better forage varieties are needed to permit Korea to further exploit her only land frontiers -- the underutilized winter paddies and the uplands. Conclusions concerning these deficiencies grew out of both (1) an examination of the Korean agricultural research establishment by Dean Pyo, Hyun Koo, College of Agriculture of the Seoul National University (COA/SNU); Director Kim, In Hwan, the Office of Rural Development (ORD); Dean James Cobble and Dr. Everett Christopher, advisors to COA/SNU and ORD; and Director Sylvan Wittwer of the Michigan Agricultural Experiment Station as part of the earlier KASS work, and (2) detailed projections through 1985 by KASS with respect to food production, food imports, foreign exchange expenditures, caloric and protein consumption, agricultural income, etc. It was clear from these projections that improving the yields and seasonal adaptability to the Korean environment of rice, other food grains, soybeans, feed grains, and forages are top priorities for Korea's agricultural research establishment. While the KASS studies indicate that marketing, food processing, and food utilization research are important, it is <u>first</u> necessary to get higher yields and increased hectarages in the basic crops. This leaves at a somewhat lower priority the problems of transporting, marketing, processing and utilizing the increased output from research. The research proposed herein concentrates only on the first step. Success in this step will lead, in turn, to the need for additional research in marketing, food technology, etc.

As part of the preparation for this report, conferences were held by the authors, with Dean James Cobble, and Dr. Everett Christopher; and at Rockefeller Foundation with Dr. Sterling Wortman, Director of the Foundation's agricultural program, Dr. John McKelvey and others from the agriculture division. These conferences indicated that the KASS conclusions with respect to the necessity of concentrating on biological improvements in the food grains, soybeans, feed grains and forages was consistent with Rockefeller Foundation experiences at the International Rice Research Institute in the Philippines, the International Maise and Wheat Improvement Center in Mexico, and with their current experiences at the International Institute of Tropical Agriculture in Nigeria and the new International Center for Tropical Agriculture in Colombia.

This report:

1. inventories Korean agricultural research institutions, programs and results;
2. surveys research experiences elsewhere in the world which are thought to be relevant for Korea;
3. presents a design for a program to expand and further develop Korean agricultural research with attention to:
   a. research and research training objectives to further development of Korean agriculture;
   b. needed resources:
      (1) personnel
      (2) equipment
      (3) land and buildings
      (4) administrative direction and support
   c. probable payoffs for research output with attention to how to use these payoffs to finance the needed changes; the payoffs will be assessed in terms of both monetary and nonmonetary impacts;
   d. how the program could be developed and implemented including financing of both domestic and offshore components.

Korean Agricultural Research Institutions, Programs and Results

Our inventory of Korean agricultural research institutions indicates substantial developments to date but (1) lack of concentration on the nations top agricultural research priorities, and (2) a shortage of resources to satisfy those priorities. Dr. Kim, In Hwan, ORD, described Korea's rather well developed agricultural research system in a recent ADC report. 1/ His organization chart is presented here as Figure 12-1, while his description is found in Appendix I to this part. In addition to the system described by Dr. Kim, the following FAO/UNDP programs are functioning or are in near final stages of approval in Korea; these include important research activities.

1. Uplands Development and Watershed Management. A budget of $1,957,000 extends through December 1973. Ten experts are attached to the project, with the Farmland Bureau in MAF serving as the counterpart organization. Three large watershed areas are involved -- Ansong Chon, Tongjin Gang, and Sangju -- and five subwatersheds where detailed work is being done.

2. Strengthening Plant Protection, Research and Training. The project is being initiated in the Institute of Plant Environment of ORD at Suwon with a total budget of $1,121,000. There will be nine experts, the first of which arrived in mid-August 1972, and six consultants. It includes a fellowship program.

3. Soil Fertility and Soil Survey. This program is continuing in a much abbreviated form compared to the past. The leader has two assistants all housed in the Institute of Plant Environment in ORD at Suwon with a budget of $235,200.

4. Forestry Survey and Development. This project is financed at $500,000. and continues until December 1973. A forestry training center project was requested but not approved.

5. Applied Nutrition. Applied nutrition work is based on a one man team in the Guidance Bureau of ORD at Suwon. The program deals with increased food production for household use, nutritional education for women, and training of project personnel. Calcium and vitamin B_2 deficiencies are the greatest nutrient problems in Korea.

1/ ADC, National Agricultural Research Systems In Asia , The Agricultural Development Council, Inc., New York, New York, 1971

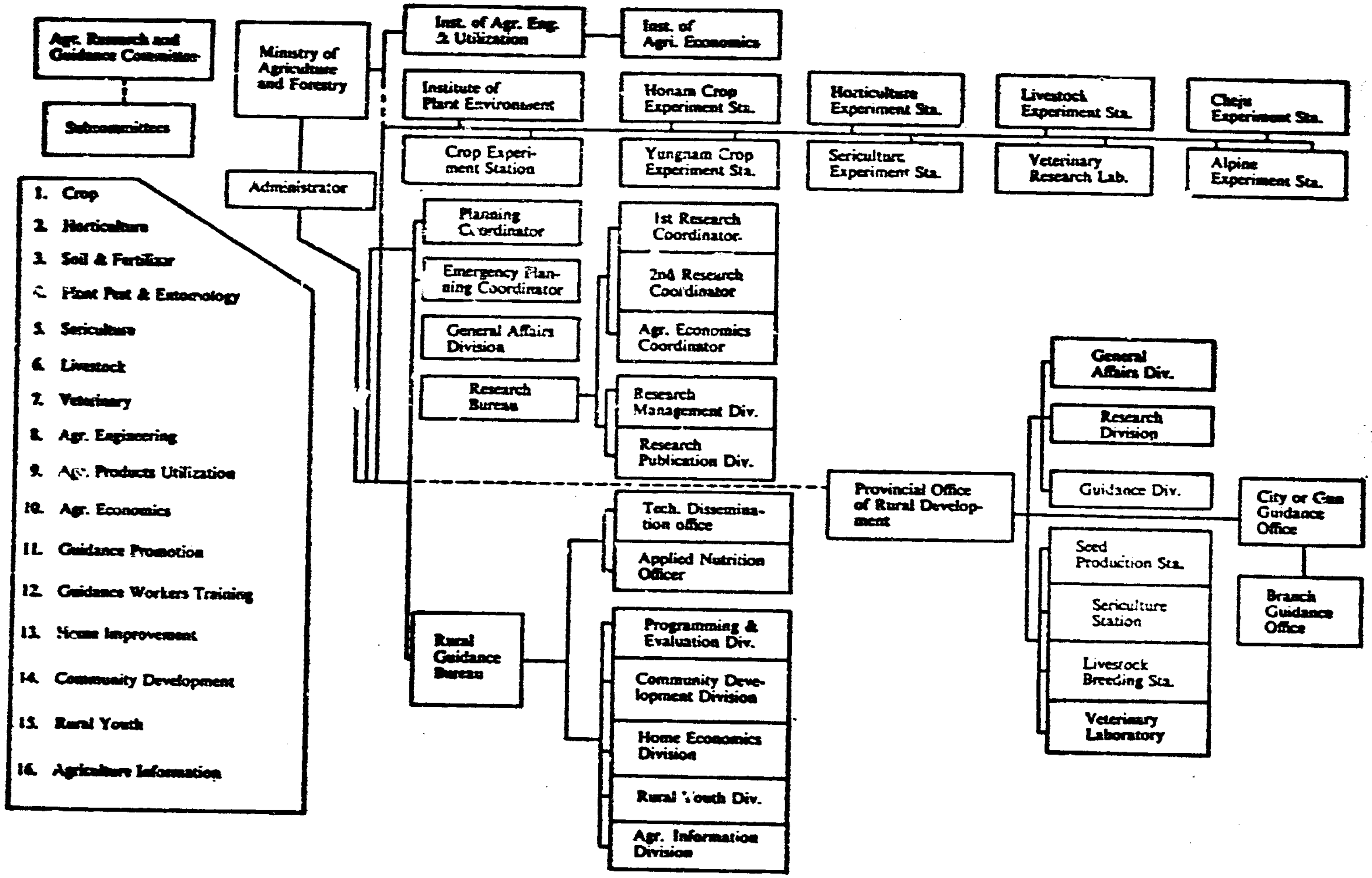

Figure 12-1: Korean National Agricultural Research System

Possible feasible solutions for vitamin B_2 deficiency would include more fresh vegetables and soybeans, and for calcium deficiency, more lime on soils for crop production.

6. Agricultural Statistician. An agricultural statistician is provided and housed in the Ministry of Agriculture and Forestry.

A. Other programs pending or underway include:

1. IBRD Seed Multiplication and Distribution Project. The counterpart agency is the MAF and there is a proposed budget from a low interest rate loan of $8,200,000. The project involves crop improvement, seed production, processing, utilization and distribution. ORD, three crop experiment stations (Suwon, Honam, Yongnam), and COA are involved as well as PORDS. One million dollars is listed for research.

Korea is seeking a low interest loan from IBRD. Seed processing factories are needed. Approval of this project, according to Park, Johng Moon, Chief, Agricultural Production Division, MAF, is pending MAF and the ROK government decision. Funds would be generated in the seed program for other parts of the loan.

As part of the seed project, a new organization in MAF is proposed, the "Office of Seed Production and Distribution" with nine POSPD's -- one for each province.

2. West German Program now in Progress on Pasture Improvement, Relating to Livestock. This program, according to Dr. Lee, Chang Koo of ORD (2nd Research Coordinator), will be started although final documents are not yet signed. Major components of the program are as follows:

a. Eight to ten people (fellowships) will be sent to Germany for one year of training each.

b. Four experts will be dispatched from Germany to work in ORD -- each for four years. These experts will come with the necessary equipment including tractors, mowers, etc. Fifteen items of heavy equipment are involved.

c. There is already 30,000,000 won available to initiate the pasture research program for 1973.

d. The plan is to eventually have a pasture research station at Suwon. (They already have the Alpine and Jeju Experiment Stations.)

e. The counterpart agency for the program would be ORD at Suwon.

3. Sheep Breeding Program (Australian). This project is just beginning or in the final stages of approval. MAF is apparently the contact, since it is not being handled by ORD. The main concern is the breeding of sheep. While there is some question as to whether Korea should have a sheep program with its current needs for soil conservation in the upland and hills, this issue presumably will be examined in the research program.

It is difficult to assemble a picture of financial support for agriculture in any country -- and Korea is no exception. Capital investments and recurrent expenditures are often intermingled, as are research, extension, and action agencies' expenditures. These difficulties plus budget revisions and accounting problems make it difficult to interpret data. Appendix II contains data from the Ministry of Science and Technology on research and development expenditures, classified by type of agency and by subject.

In general, research institutes receive the bulk of the research budget -- roughly 100 times the research budget of colleges and universities and 50 times the research budget of private industry. Crop research accounts for about a third of the budget. Livestock gets about a 20th not counting forage research at the Alpine Station which is budgeted at about 86 million won. Forestry and fishery research accounts for less than 5 percent while inspection, which is hardly research, accounts for almost one-fifth of the budget.

In addition to personnel in the ORD research facilities and the other research activities summarized above, there are the important personnel resources in the Colleges of Agriculture. For examples, there is more trained manpower in the COA of SNU than in ORD though, of course, that manpower has heavy teaching responsibilities. Currently an AID contract is providing two consultants, Dean James Cobble and Dr. Everett Christopher, to assist in establishing working arrangements to more fully utilize the teaching skills in ORD and the research skills in the COA.

Korea s agricultural research establishment can be characterized in the following ways:

1. It is a national system relatively unfocused on the nations research priorities.

2. It is poorly equipped, though ORD is much better equipped than COA/SNU and other research centers.

3. It is short on highly trained personnel.

4. It is relatively well housed and well provided with land for scientific investigations.

5. The system is relatively well balanced with respect to disciplinary areas and subjects such as plant protection, soils, etc.

6. However, this system is short on equipment, maintenance facilities and personnel, and on operating funds.

Previous agricultural studies have been less comprehensive than the recently completed KASS effort and did not determine national research priorities; hence, there have been few efforts to focus the Korean agricultural research establishment on the priorities revealed by the KASS study. There is a substantial effort underway in rice, while barley and wheat research needs have been examined, and progress is being made on forage research, particularly upland perennials. However, Korea's agricultural research results are as yet relatively unfocused on the subjects of highest national priority.

Relevant Experiences Elsewhere in the World

An examination of world experiences with agricultural research indicates at least four prerequisites for success in attaining the national research goals and priorities established by KASS. 1/ These prerequisites are:

1. The existence of a national research organization. Korea has this prerequisite in ORD and now has advisors on coordinating ORD and College of Agriculture research to complete the task of establishing a national research structure.

2. Either a critical national mass of genetic material, plant breeders and ongoing plant breeding activities or

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1/ National Agricultural Research Systems in Asia, Edited by A.H. Moseman, The Agricultural Development Council, N.Y., N.Y., 1971, and A.H. Moseman, Building Agricultural Research Systems in the Developing Nations, the ADC, N.Y., N.Y., 1970.

access to such a component. Historically, the larger, more developed countries developed their own critical masses while the smaller, less developed countries borrowed, got along without, or were supplied with critical masses for their export crops by more developed, importing countries. Fortunately, the international agricultural research institutes have now amassed genetic materials and plant breeders for rice, wheat, and corn, and are making progress on forages, sorghum, barley, triticale, livestock, and other food crops. Thus, Korea can draw on the critical masses located in the international institutes as well as those in North America, Europe and Oceania.

3. Ability to establish large scale crop improvement programs which are problem oriented and multidisciplinary in nature. Examples include the corn hybridization programs, and India's wheat improvement program. Other examples include the work on oil palm at the West African (now Nigerian) Institute for Oil Palm Research and the corresponding French, British and Dutch efforts for cocoa and rubber. Korea is just now reaching the stage where it can organize such crop improvement efforts.

4. A strong policy and program commitment on the part of government or other funding agency needed to mobilize personnel, institutional, physical, and financial resources into crop improvement programs. As yet, Korea does not have sufficient policy and program commitment in either government or private industry to focus its agricultural research establishment on the national research priorities of the country.

The KASS group saw the need to concentrate, focus and further support Korea's agricultural research effort. Consultations with Rockefeller Foundation personnel, who are experienced in establishing international agricultural research establishments and in assisting national efforts, resulted in our placing even greater emphasis on this need. The computerized KASS projections indicated the crucial importance of concentrating on feed grains, food grains and forages in order to get the increases in productivity which would result in "second generation problems" involving marketing, processing, distribution, and, later, in "third generation problems" involving income distribution as increased agricultural production yields higher incomes for the portion of the rural population in position to benefit from the technological advances. Neither we nor the KASS team would neglect agricultural economic and sociological research involving marketing, processing and distribution of foodstuffs or income distribution problems. Elsewhere, KASS has made the case for improvement in agricultural policy analysis and marketing research in Korea; however, despite the high proportion of agricultural economists on the KASS team, it is clear that substantial advances in biological and chemical technology is of such high priority that research programs specialized in this ares must be given top priority.

It is now time for the Korean government to extend its commitment to a policy and program for rice and other food grains, feed grains, perennial forages for uplands, and annual forages for winter paddies. Such a commitment, it will be argued, is necessary in order to mobilize Korea's agricultural research establishment to focus its present resources and the resources it can acquire, on the attainment of national long run agricultural targets. The details of the argument will not become clear until the proposed research policies and programs are described along with estimates of the resultant benefits and costs.

Proposed Crop Improvement Policies and Programs for korea

This proposal involves targets, payoffs, programs, resource requirements and costs, and implementation. Each of these is discussed below.

Targets. The crop improvement policies and programs proposed herein have practical yield and hectarage targets. The yield targets in metric tons per hectare by area 1/ for 1975 and 1980 are compared with 1971 actual yields in Table 12-1. For comparison purposes, Table 12-2 indicates KASS projected yields, 1975 and 1980 under Alternative I presumption of a continuation of the Third Five Year Plan policies as published and without the expanded crop improvement programs advocated herein.

1/ Tables 12-1 through 12-4 use KASS area definitions. Area I includes Kyenggi Do, Area II includes Chungcheon Nam Do Gyeongsang Bug Do, Gyeongsang Nam Do, Jeolla Bug Do, Jeolla Nam Do, and Area III includes Jeju Chungcheon Bug Do , Janweon Do, and Jeju.

Table 12-1: Proposed Research Program Yield Targets for Rice, Barley, and Wheat, by area, 1975 and 1980, and Actual Yields, 1971

Commodity	1971 Actual Yields			Targeted Yields 1975			Targeted Yields 1980		
	I	II	III	I	II	III	I	II	III
	-- area --			-- area --			-- area --		
Rice	3.3	3.2.	2.7	3.9	3.7	3.3	4.8	4.5	3.9
Barley	2.0	2.2	1.8	2.2	2.4	2.0	2.9	3.6	2.9
Wheat	2.2	2.2	2.2	2.3	2.3	2.3	3.1	2.5	3.0

Table 12-2: KASS Alternative I Yield Projections for Rice, Barley, and Wheat, by Area, 1975 and 1980

Commodity	Projected Yields 1975			Projected Yields 1980		
	--- area ---			--- area ---		
	I	II	III	I	II	III
	MT per ha.					
Rice	3.7	3.5	3.0	3.9	3.7	3.1
Barley	2.1	2.3	1.9	2.3	2.5	2.0
Wheat	2.2	2.2	2.2	2.4	2.4	2.4

Subobjectives of the proposed improvement policies and programs should include earliness, cold resistance, and improved adaptability to cropping systems which will more fully utilize presently unused winter paddies and uplands. Prospects for attaining this subobjective are good and justify setting the hectarage targets indicated in Table 12-3. These targets compare with the Alternative I projections shown in Table 12-4 which KASS estimated would prevail without the expanded crop improvement program advocated herein.

Table 12-3: Proposed Research Program Hectarage Targets for Rice, Barley, and Wheat, by area, 1975 and 1980, and Actual Hectarage, 1971

Commodity	Actual 1971 Hectarage				Targeted Hectarages 1975 area				Targeted Hectarages 1980 area			
	I	II	III	Tot	I	II	III	Tot	I	II	III	Tot
	1000 Hectares											
Rice	348	743	131	1222	339	748	132	1219	320	748	132	1210
Barley	135	718	95	948	150	720	100	970	250	800	150	1020
Wheat	34	107	29	170	35	115	30	180	40	140	40	220

Table 12-4: KASS Alternative I Hectarage Projections for Rice, Barley, and Wheat, by Area, 1975 and 1980

	Projected Hectarage 1975 area				Projected Hectarage 1980 area			
	I	II	III	Tot.	I	II	III	Tot.
	1000 Hectares							
Rice	330	724	127	1190	333	711	125	1169
Barley	133	712	94	939	135	722	95	952
Wheat	33	105	28	166	33	102	27	162

The crop improvement policies and programs would also have the objective of:

1. developing administrative capacity to mobilize multidisciplinary problem solving research programs;
2. developing satisfactory undergraduate and graduate COA programs and noncollege, in service training opportunities to insure an adequate supply of personnel with both:
   a. the disciplinary competence required to contribute to multidisciplinary efforts, and
   b. the motivation to contribute to multidisciplinary, problem oriented, crop improvement work and to exploit these work experiences to make their disciplinary contributions more relevant.

Payoffs. Substantial benefits are associated with these policies and programs. The benefits are nonmonetary as well as monetary and qualitative as well as quantitative. A number of the quantitative benefits are estimated and presented in Table 12-5 and are followed by a discussion of other "qualitative" benefits.

The national impacts of attaining the targeted yields and hectarages versus a continuation of present trends are shown in Table 12-5 and were projected using the computerized KASS model.

Table 12-5: Consequences on Selected Performance Variables of Attaining Research Program Targets, 1975, 1980

Performance Variables	1975 Present Trends	1975 Targets Attained	1980 Present Trends	1980 Targets Attained
Agr. value added, total, bil. won	654	680	771	901
Agr. value added, per cap. thou. won	42.3	44.0	58.9	68.8
Agr. income, total, bil. won	748	775	852	982
Agr. income, per cap. thous. won	48.4	50.1	65.1	75.0
For. Ex. used to buy Agr'l products, bil. won	88.8	623	137.4	6.1
Rice deficit, thou. MT	876	520	1255	104
Barley deficit, thou. MT	61	-65	-296	-2015
Wheat deficit, thou. MT	1004	963	1391	1048
Returns per hectare, rice thou. won	169	180	167	214
Returns per man year, rice thou. won	230	240	224	264

These are substantial benefits. The increases in value added and in agricultural income are in terms of constant 1970 level prices for rice, barley, wheat, and all other commodities. As the price policies built into the alternative strategies analyzed by KASS would increase these value added and income figures considerably, they should not be compared with the KASS projections. With agricultural value added, increases ranging from 26 billion won or 65 million U.S. dollars in 1975 to 130 billion won or 325 million U.S. dollars in 1980, additional annual expenditures of 2 million U.S. dollars per year, as proposed later, are more than amply justified. At constant prices, value added per year would be increased 32.5 times the annual cost of the proposed program by 1975 and by 162.5 times by 1980. Rice, barley, and wheat deficits would be cut 356, 126, and 41 thousand MT respectively by 1975 and 1151, 1719, and 343 thousand MT respectively by 1980. With adjustments in rice, wheat, and barley prices relative to each other and relative to other commodities, these deficits could be further reduced. As KASS projections assume such adjustments, these estimates, which are designed to isolate the impact of the recommendations made herein, should not be compared with the KASS estimates. As Korea was only importing small amounts of barley such a reduction in the deficit results in a projected 1980 "surplus" which could be utilized in a variety of ways as its development would make it possible to lower the price of barley. With lower barley prices, human consumption will expand both as grain and in the form of alcoholic beverages. Also important will be expanded use of barley as feed for poultry, pork, dairy and beef production.

The above estimates and benefits do not take into account possible benefits from improving soybeans, forages and livestock/crop production systems which will also accure from the research program recommended herein.

The benefits to be derived from the proposed research program will be widely spread throughout the Korean economy. Foreign exchange will be saved. The country will enjoy the security of a greater degree of food self-sufficiency. Yet, consumers will be better fed and food prices will be lower than they would be if equal food self-sufficiency were obtained primarily through price increases rather than through the biological advances sought in the recommended research program.

As pointed out in the KASS report, Korea has a problem of maintaining farm prices and incomes at levels which will equate off-farm migration with the rate at which productive employment opportunities can be generated in the nonfarm economy. The increased agricultural productivity stemming from this proposal will permit internal food prices to be lowered nearer world levels. This would, in turn, lower consumer expenditures on food while increasing Korea's level of food self-sufficiency. Foreign exchange savings would be about 26 billion won or 65 million U.S. dollars in 1975 and approximately 131 billion won or 325 million U.S. dollars by 1980.

The widespread diffusion of many different benefits and the lack of a central point in the marketing process where taxes or assessments can be levied will make it difficult to collect from beneficiaries of the proposed program to repay financing from external or domestic loans.

Much of the greater output will not pass through central points on the way to export markets or to domestic processors as is true in the case of, say, rice in Thailand which is exported, cocoa in Nigeria which is also exported, or cotton in Nigeria which passes through a centralized government agency enroute to domestic spinners and weavers. The very high ratios of return for this investment program and the wide diffusion of the benefits throughout the economy make it possible and appropriate to ultimately recover costs through general tax revenues of the Korean government. By increasing the domestically produced portion of total food demanded at a lower per unit cost, farm household incomes will increase, consumer food prices will decrease, and foreign exchange will be saved. Thus, the basis is provided for financing the program with foreign loans or from central government general revenues to be paid off by tax revenues.

The yield and hectarage targets presented herein are accepted as reasonable by Korean and American agriculturalists. However, it must be recognized that they are judgmental in nature and that errors in judgment would influence the benefits discussed above. To gain insights into how such errors could adversely influence these benefits, two additional sets of projections were run on the KASS model. The first cuts the yield targets by half the difference between KASS yield projections for present trends and our target yields and the second allows five additional years to attain the targeted yields.

Benefits remain high in both cases. At constant prices, value added per year in agriculture would be increased by 39 times the annual costs of mounting the crop improvement programs proposed herein for 1980, even when yields are dropped by half the difference between trend and target. When results are delayed an extra five years, the benefit-cost ratios fall substantially but still exceed annual costs by 5.5 times in 1980 and by 26 times in 1985.

Programs. Crop improvement programs are recommended for rice, barley and wheat, and soybeans. In addition , a research program on crop and livestock systems is recommended with emphasis on forage improvement.

1. Rice. This is the number one crop and holds number one priority in any research program for Korea. Rice yields have been and still are lower than those in Japan. The program should emphasize new variety development, with accompanying improved cultural practices and handling procedures, to maximize the productivity per unit of land area. The recent introduction of IR-667 (Tong-il) is only a beginning. Less than 20 percent of the acreage was planted to IR-667 in 1972. It is the only variety in Korea highly resistant to the blast fungus, highly resistant to strip virus, and moderately resistant to stunt virus, and the small brown plant hoppers, and the green leaf hoppers, respectively, which are the insect vectors for the two above named viruses. IR-667 is also high yielding, resistant to lodging, and responsive to fertilizer.

The tremendous need and opportunity for additional research with rice in Korea is revealed in that IR-667 (Tong-il), with all of its advantages, is very susceptible to low temperatures at all stages of development (seed germination to grain maturation), it has inferior quality because of high (23 percent) amylase, it shows excessive breakage in milling because of long irregularly shaped grains, it is susceptible to bacterial leaf blight, rice stem borer, the brown plant hopper, the white back plant hopper and the zigzag hopper. Furthermore, IR-667 lacks the desired stickiness and the cooked product is too fluffy for Korean tastes. Furthermore, shattering of rice was no problem in Korea until IR-667 came along. It shatters in the field, when it is cut, spread, turned, bundled, and transported. Losses range from 9 to 20 percent. Improved varieties and harvest handling machines for rice need to be developed. If harvest operations were properly mechanized, the present disadvantage of shattering ease might become an asset.

Current agricultural research with rice in Korea is further advanced and better coordinated than in any other research area or with any other commodity. There is an existing nucleus of an 8 man coordinated rice research team in the COA/SNU, with an active complementary program at the Crops Experiment Station of ORD at Suwon and the Honam and Yungnam Stations of ORD. The coordinated rice research program in the COA/SNU consists of more than just plant breeding. There are two plant pathologists, two entomologists, a plant physiologist and a biochemist on the team

While the research effort at the COA/SNU is coordinated as an 8 man "team", the team consists of professors who have full time teaching assignments in the college. There is little or no release time for research, little money to support it, and a great deficiency of equipment and facilities with which to pursue it.

A significant increase in rice yields is projected for 1975 without a major increase in research resources above the present level (Table 12-2). This will come as a result of the already catalytic influence of the IR-667 (Tong-il) variety recently introduced and with the minimal work now in progress at COA/SNU and ORD on improving cold resistance and tolerance to several diseases and insects. More earliness in new rice varieties is achievable and extremely important. It would expand the double cropping paddy potential with barley and wheat.

Much of the capacity of the new ORD phytotron is being utilized for cold resistance studies. New varieties need continuing improvement, particularly in disease and insect resistance. Without an additional research investment, much of what might be gained by 1975 would be lost by 1980. IR-667 yields on the test-demonstration areas averaged 5 tons/hectare in 1971. Yields of 4.5 tons/hectares are projected for 1972. This would be a 1.1 MT per hectare increase in yield over present indigenous varieties for the hectarage planted to the new variety. Dr. Hue of COA/SNU projects a 10 percent overall yield increase in 1972 over 1971. KASS estimates are more conservative at about a 5 percent increase in overall yield due to the 200,000 hectares of IR-667 between 1971 and 1972.

There are also potential opportunities for upland rice where no research has been done with new high yielding varieties. The present 40,000 hectares of upland rice is of very primitive types with low yields and strong tendencies to lodge. Upland rice improvement holds excellent payoff potential for Korea since it is more drought resistant than paddy rice, and farmers like to grow it in the uplands. Competing crops are corn, sorghum, soybeans and millet.

The projected 45-50 percent increase in rice yields for Korea by 1980 are considered realistic by both COA/SNU and ORD administrators and researchers, but only if significant new resources are made available for a concentrated and coordinated research program.

2. Barley and Wheat. Research priority in these grains is second only to rice. There are currently 432,000 hectares of winter barley on paddy and 48,000 hectares of wheat for a total of 480,000 hectares of double-cropped paddy in Korea. In addition, there are 640,000 hectares of barley and wheat on upland. There is great potential, with earlier maturing, more productive, lodging and disease resistant winter wheat and barley varieties to substantially increase land utilization in Korea. Projected yield increases by 1980 could be highly significant (35-50 percent) with additional research resources.

Research with barley is in its infancy. Little progress could be expected by 1975, even with the initiation of new investments in research; but very significant progress could be made by 1980 with variety improvement emphasis on earliness, disease resistance, lodging resistance, and improved culture. Improved mechanization of land (along with drainage) needs considerable research input. A scab (Gibberella Zea) resistant barley for Korea is very important. Scab in barley is weather dependent and nothing promising in varietal resistance has yet been identified. Little progress has been made to date on wheat. Even with new inputs in research, little could be accomplished by 1975. Current wheat research is limited and it is not likely that even with improved cultural techniques there will be much impact within the next three years. Significant progress should, however, be made by 1980, with emphasis on disease resistance, earliness, high yields and lodging resistant, fertilizer responsive types. As with barley, the greatest yield increases will occur in the double paddy areas.

Considerable input can come to the wheat and barley breeding programs in Korea via a germ plasm and information exchange with CIMMYT, ARS-USDA and state experiment stations in the U.S.A.

The above (Table 12-2) yield projection increases for 1980 are about equal for rice, barley, and wheat. Historically, more progress has been made world-wide with wheat than with rice, but current rice research in Korea is far ahead of wheat and barley.

If the wheat and barley seasons could be shortened by 10-15 days, grain production would be revolutionized in Korea. Earlier varieties with concomitant earlier maturity would circumvent many existing disease problems and the late spring and early summer droughts. Total peak labor demands would be reduced with greater time between rice harvest and barley and wheat planting.

3. Soybeans. Research needs with this crop are second only to rice and barley and wheat. Soybeans along with the upland portion of the hectarage (640,000 ha.) of barley and wheat constitute the base or nucleus for a research program on upland crops. A breeding program should be initiated beyond the current variety testing and observation trials of ORD. Soybeans and their products (soy sauce, curd, milk, sprouts) have been eaten for centuries in Korea. The current 400,000 hectares of soybeans in Korea consist mostly of primitive varieties with very low yields.approximating only .6 MT/hectare in 1965 and .8 MT/hectare in 1971. Experimental yields of 2 MT/hectare have been produced.

Improved, higher yielding varieties of soybeans and their culture in Korea on upland soils would not only add more high protein food to the diet, but would complement industrial needs as the economy advances. An expansion in the production of this crop would double as a soil conservation practice for upland areas. Soybeans enrich the soil with nitrogen through biological nitrogen fixation and are excellent in crop rotations.

A research program with rice, barley, and wheat, and soybeans would complement the proposed IBRD financed seed improvement project which deals precisely with the same crops. Rice, barley, wheat, and soybeans constitute the staple food base of Korea. Increased productivity of these commodities will reduce imports and eventually release land for other crops. Along with the above proposed crop improvement programs, should be one on forage-livestock systems. Present research resources include the Livestock (and forage) Experiment Station at Suwon, an Animal Breeding Station administratively under MAF and located 30 miles south of Suwon, and the Alpine Station near Daekwan Ryong.

Approximately one million native Korean cattle are currently used as draft animals. The imminent advent of mechanization of farm operations provides a setting appropriate for the development of expanded beef and dairy industries, based on expanded and improved grass-legume pastures on the uplands. Substantial forest land could be reclassified as pasture land. KASS estimates indicate that about 115,000 hectares of forest land could be converted as pasture and grass land, and which if so converted, would not only reduce erosion and be an improved soil conservation practice, but serve as a feed base (forage) for an expanded livestock industry as well.

A research program on upland forages grown during the spring, summer, and fall should focus on grass-legume mixtures, improvement of native as well as imported species and the alleviation of the summer growth depression.

There is a second potential land frontier for production of fall, winter, and spring forages on what is now the single crop paddy land of the northern part of the country. Fall and spring plantings of Italian rye grass have, in experimental trials at ORD, given average yields of 3,353 kg./.1 hectare, and 2,937 kg./.1 hectare, respectively, with top yields of 6,300 and 5,630 kg./.1 hectare, respectively. Tests have shown that Italian rye grass is preferred over other grasses as cattle feed. There is also a favorable response for the rice crop which follows.

Winter forages such as Italian rye grass could be started as early as mid-October or even earlier in rice paddies in the north, by seeding in the rice before harvest. The crops could also be extended to June 1 to achieve maximum forage production. Due to labor constraints, one possible alternative would be to seed winter forages on only half the paddy hectarage in a given year. For a given area and year, this forage hectarage could be the first rice hectarage harvested in the fall and the last planted in the spring. Not all paddy land would be suitable because of inadequate drainage. Maximum utilization of winter paddy may require a rice/winter forage/rice/barley/rice/winter forage rotation with rice planted early and late in alternate years. There is much needed research in this area as to species of forage (grasses and legumes), fertilizer treatments, and cropping systems.

While some larger scale dairy and beef farms may develop in the future in the uplands, there is likely to be an opportunity to replace draft animals with one or two beef, dairy or multipurpose animals on many of the present small rice producing farms as consumer incomes and, hence, demands for beef and dairy products increase. These enterprises will require higher quality forage than presently used for draft animals. Coupled with rising incomes and higher industrial wage rates will be off-farm migration, necessitating investments in labor saving equipment. In some instances, the livestock production systems of Norway may be more appropriate models for Korea than those of the U.S., New Zealand, or Australia. Attention might also be given to livestock production systems used earlier in the UK and in the low countries of Western Europe. The labor intensive, small scale of many of the former Western European livestock systems might be quite applicable to Korean conditions in the next two or three decades. From the above discussion, it is clear that farming systems need to be studied in Korea with particuler attention to the problems of developing means of exploiting potential forage producing resources, in both the uplands and in the winter paddies, to provide livestock products,year around employment for farmers, and a higher level of living for Korean people.

Needed Resources and Costs. The resources needed to attain the above objectives are mainly personnel -- scientific and administrative -- and equipment. In general, the Korean agricultural research establishment possesses sufficient buildings and land to mount crop improvement programs for rice, barley, wheat, and forages. In addition, there are facilities for work on related crop and livestock production systems, without reducing present support for mushrooms, fruits, vegetables, potatoes and silk.

Table 12-6: Personnel Needs and Costs for Proposed Additional Research Program

	Cost
Director, plus supporting personnel, etc.	$100,000
Associate Director	75,000
Additions to staff of COA/SNU and ORD (and at Honam and Yungnam)	
<u>Rice</u> 25 scientists plus supporting personnel (insofar as possible from Korean agricultural colleges alumni now abroad)	250,000
<u>Barley and Wheat</u> 20 scientists plus supporting personnel (insofar as possible from Korean agricultural colleges alumni now abroad)	200,000
<u>Soybeans</u> 10 scientists plus supporting personnel (insofar as possible from Korean agricultural colleges alumni now abroad)	100,000
<u>Forages</u> 20 scientists plus supporting personnel (insofar as possible from Korean agricultural colleges alumni now abroad)	200,000
Total Personnel Costs	$925,000

As recommended by KASS, many of the research scientists as well as the administrative cadre should be brought to Korea from outside since there is not time to develop the necessary skills in Korea before research results are needed. The director should be a highly skilled administrator who is knowledgeable in rice and in one other crop.

Equally important is an associate director to backstop the director, take over in his absence, and be in charge of two of the crop improvement programs including the barley and wheat program. The director and associate director must have budget control and a free hand to coordinate the research activities now diversely spread in many agencies.

The 25, 20, 10, and 20 new scientists recruited for rice, barley and wheat, soybeans, and forages, respectively, should insofar as possible be Koreans who have or will be shortly getting advanced (Ph.D.) degrees abroad and who are alumni of Korean colleges of agriculture. According to Dean Pyo of COA/SNU, there are adequate numbers of well trained Ph.D. scientists now in the U.S.A. or elsewhere who would welcome a research, or research-teaching position in Korea. (See Appendix III for list prepared by Dean Pyo, COA/SNU.)

No substantial need exists for input into more or new facilities since it appears that space in buildings and land is available if properly utilized. Equipment inventories, however, are inadequate. Equipment needs for the proposed research program would have to be worked out by knowledgeable researchers in a team assigned the task of actually developing the crop improvement programs. A helpful document in this regard is a report which contains an indication of equipment needs as currently envisioned by G.E. Estes for COA/SNU and ORD. 1/

Another deficient area is the scientific libraries which consist of buildings inadequately stocked with books and periodicals. The crop improvement programs advocated herein would require a substantial expenditure on library materials focused specifically on crop improvement progress for rice, barley, wheat, forages, and combined cropping and livestock production systems.

About $500,000 would be needed annually for equipment, technicians, library materials, and librarians. In addition, $5-600,000 should be allowed annually for other expenses and contingencies. Thus, a total annual budget of about $2 million for ten years is recommended, subject to adjustment by the planning team.

1/ Estes, G.O., " A Status Report Including Recommendations Concerning Laboratory Instrumentation and Equipment at COA/SNU and ORD, Suwon, Korea," 1972. Copies are available from Rural Development Division, USAID/K Seoul, Korea.

The Need for a Planning Team

Road and dam building projects are generally preceded by prefeasibility and feasibility studies. The Korean Agricultural Sector Study and this report serve as a prefeasibility study and indicate that the proposed crop improvement research programs are needed and hold strong promise of success in obtaining financial returns exceeding outlays more than one hundred fifty-fold.

The next step to be taken is the establishment of the equivalent of a feasibility study better called, in the case of research and development programs, a Phase I Planning Team. However, such a team should not be constituted until the Korean government has committed itself to a priority policy of and increased resources to programs for seeking rice, barley, wheat, soybean, and forage crop improvement. The government will also need to bring its administrative power to bear on the problem of focusing Korean research resources on such objectives. The following suggestions are made with respect to the Phase I Planning Team.

1. Composition of Team. The team should be composed of and draw on personnel experienced with specialized international agricultural commodity research institutes and national crop improvement programs. Expertise in rice, barley, and wheat breeding are important as are administrative skills and research entrepreneurship. The team should have contact with KASS researchers so that the computerized KASS agricultural sector model can be used to estimate the extent to which Korean national priorities would be fulfilled by alternative crop improvement programs. Personnel suggestions for the team and consultants are found in Appendix IV.

The team should include the prospective project director and associate director and should include representatives of institutions likely to furnish resources, leadership, and genetic material. The team should include KASS personnel or have access to the KASS simulation model so that that model can be used in appraising the long range potential of the project the team designs.

2. Duration of Planning Team's Effort. Two to six months should be adequate.

3. Terms of Reference for the Phase I Team.

a. To evaluate the recommendation in this report that Korea establish four separate, national agricultural research efforts -- three crop improvement programs (rice, barley and wheat, and soybeans) and a fourth improvement program on crop and livestock farming system and, if it deems it advisable, to modify those recommendations.

b. To verify in terms of policy, personnel, and resources the extent of a Korean national commitment to make substantial progress in obtaining the yields and hectarages targeted for rice, barley and wheat in this report and to make substantial progress on soybeans and forages.

c. To develop for a ten year period:

(1) a staffing program

(2) equipment lists

(3) estimates of recurrent expenditures.

In developing these programs, lists and estimates, it will be necessary to inventory and evaluate Korea's qualified agricultural research manpower. Attention should be given to Korean capacity to add to and upgrade its reservoir of agricultural researchers. Particular attention should be given to the long time future (15-25 years ahead). In the long pull, expatriate personnel, new equipment, added space, and increased budgets cannot take the place of a pool of in-country researchers who are highly trained and professionally oriented and who are motivated to acquire knowledge and find reliable answers to agricultural problems.

d. To develop a plan for organizing the required crop improvement and farming systems programs:

(1) within the Korean government

(2) covering relationships to possible external grantor, lender, and technical assistance agencies.

e. Specific plans for financing each of the four programs including Korean support, suggested granting and lending agencies (and alternatives), and possible sources of revenue to cover debt service and debt service schedules.

Part IV

APPENDICES

Appendix I 1/

Agricultural Research in Korea

IN HWAN KIM
Administrator, Office of Rural Development, Ministry of Agriculture and Forestry, Suwon.

The Office of Rural Development (ORD), with main headquarters at Suwon, Korea is charged with the modernisation of agricultural research. This programme began over half a century ago. The major goal of ORD is to implement government agricultural policies of: (a) self sufficiency in food production, (b) increasing farm income, (c) farm mechanisation, and (d) crop diversification.

The Office of Rural Development is under the administrative control of the Ministry of Agriculture and Forestry but enjoys considerable autonomy and flexibility in planning and implementing research programmes.

HISTORY OF AGRICULTURAL RESEARCH IN KOREA

1905–1945

A modest beginning of organised research dates back to 1905 when an agricultural demonstration farm, under the direction of the Ministry of Agriculture and Commerce, was established at Seoul. This station was the only farm conducting agricultural research in Korea. In 1906 the station was moved to its present location in Suwon and at the same time an agricultural school was founded near the farm. The purpose of having the research farm was to obtain basic data for farming and to introduce modern agricultural farming techniques to Korean farmers. In 1929, the farm was renamed the Agricultural Experiment Station and several branch stations were established in different localities.

1946–1956

In 1946, the station was renamed the Central Agricultural Experiment Station. The Central Livestock and Horticulture Institutes were established in 1952 and 1953 respectively. Research during the decade included a systematic listing of various crop varieties together with the selection of superior varieties and the dissemination of seeds, breeding stock and vaccine to farmers. A basic plan for soil classification was carried out. The selection of better vegetable varieties, the establishment of a production system and a properly managed vegetable seed multiplication programme were also implemented.

1/ ADC, National Agricultural Research Systems in Asia, edited by Albert H. Moseman, The Agricultural Development Council, Inc., N.Y., N.Y., 1971.

Establishment of the Agriculture Institute in 1957

The coordinated activities in research and extension were largely the result of the proposal submitted in 1956 by Dr. Harold Macy, Dean of the Institute of Agriculture, University of Minnesota. An Agricultural Extension Act was inaugurated and became effective in February, 1957. Accordingly, the Institute of Agriculture was founded, combining a total of 29 organisations under one agency. The Institute undertook the massive task of rehabilitating, reorganising and reconstructing badly damaged, destroyed or non-existent facilities. With generous support from the U.S. International Cooperation Administration (ICA) and the Korean government, funds were made available for facilities and various items needed for the research, extension and training programmes.

After establishing the Institute, rapid progress was made in many fields of research with emphasis on developing superior varieties of food grain, improved cultural practices, plant nutrition, animal breeding, forage production and cash crops (vegetables, sericulture and fruits). Several major accomplishments were the production of hybrid corn, virus-free seed potatoes, a vegetable seed industry, the development of new soybean varieties, experiments in land reclamation, the manufacture of veterinary biologicals, and many other agricultural advancements.

Establishment of the Office of Rural Development in 1962

The Rural Development Act was enacted to establish a more efficient system of rural guidance and to assist in obtaining expanded and intensified rural programmes necessary for implementing the reconstruction of the nation's economic independence. The Office of Rural Development was founded in 1962. The Office succeeded the former Institute of Agriculture and was assigned the functions, authority and responsibility of developing Korean agriculture through scientific studies. The slightly new direction was based principally on the success of previous work. All available funds, facilities and scientists are used to help the rural farmer raise his standard of living and advance the Government's Rural Modernisation Programme.

The balance of this paper will describe in some detail the structure and functions of the Office of Rural Development and, specifically, the staff and research facilities now available, implementation of programmes, plans for the future and some notable past accomplishments.

IMPLEMENTATION OF RESEARCH PROGRAMMES

Principles of Operation

To assist in carrying out the research programme properly, an Agricultural Research and Guidance Committee was organised and has functioned since 1957. The Committee's main functions are to review and analyse each project, promote research programmes where necessary and ensure as far as possible that all resources are used to the best advantage. The Committee consists of faculty members from the Agricultural Colleges and Universities and most of the senior staff from the Office of Rural Development. The Committee, upon review, recommends projects to the Office of Rural Development for implementation.

Funds

The funds needed for various research activities of the ORD are provided by the Central Government. The Office subsidises funds for regional research programmes at the Provincial Offices of Rural Development (PORD). The ORD also operates a system of research grants to the Agricultural Colleges, mainly for workers in university departments, and in other research organisations. These grants provide short-term assistance for projects which are of interest to the development of the agricultural sciences.

RESEARCH AT THE AGRICULTURAL COLLEGES AND UNIVERSITIES

There are now ten state supported agricultural colleges and several private university departments conducting research in agriculture. These institutes are administratively controlled by the Ministry of Education (while ORD is under the Ministry of Agriculture and Forestry) and policies are directed primarily to the undergraduate training level with relatively undersupported postgraduate training. Also, fewer research opportunities are given to the faculty staff at the agricultural colleges and universities.

The Office of Rural Development, under these circumstances, is strengthening the system of coordinated operations between the Office of Rural Development and the agricultural colleges. Under this system of mutual cooperation, 62 selected faculty members from agricultural colleges are members of the Agricultural Research and Guidance Committee. Twenty-eight members of this committee have actively participated in joint research projects at the ORD Research Station.

ORD also provides financial grants to selected colleges to support specified agricultural research projects. This close cooperation and financial support has produced a number of remarkable research accomplishments. Two in particular are worthy of mention: (1) a detailed survey covering 123,000 ha. of potential grassland was completed, and (2) the new and improved rice variety IR-667 was a result of this joint cooperation. Varietal improvement of other foods are under study on a continuing basis.

PRESENT ORGANISATIONAL STRUCTURE OF ORD

As shown in the organisation chart in the Appendix there are two bureaus, namely the Research Bureau and Guidance Bureau, and ten subordinate research stations at the national level, under the jurisdiction of the Office of Rural Development. There are also two national research institutes under the Ministry of Agriculture and Forestry which are cooperating closely with the research stations listed. These are the Institute of Agricultural Engineering and Utilisation and the Institute of Agricultural Economics.

In each province there is a Provincial Office of Rural Development (PORD) and under the PORD there are two Divisions, namely a Research Division and a Guidance Division. In addition, there are seed farms, a Veterinary Diagnostic Laboratory and a Sericulture Experiment Station. There are also 172 city or county guidance offices and 618 guidance branch offices throughout the country.

FUNCTIONS

Research Bureau

The planning, coordination, and evaluation of all research programmes and activities conducted at the various research stations, under the Office of Rural Development and the Provincial Office of Rural Development are handled by this bureau. These responsibilities are administered by the Director of the Research

Bureau who is directly responsible to the Administrator of the Office of Rural Development. The Research Bureau is functionally subdivided into three divisions for carrying out its responsibilities. These are: a Research Coordination Division, a Research Management Division and a Research Publications Division. These divisions are concerned with research administration in the planning, coordination and evaluation of all research programmes both current and contemplated, the appropriation and allocation of research funds to the various research agencies, operation and management of the library, publication of all research data available, and the exchange and procurement of reference publications and research equipment. Other important activities are coordination and adjustment of research projects between national and provincial research agencies including the multiplication of seed, seedlings and silkworm eggs, and veterinary vaccine production.

PERSONNEL

The ORD staff has increased steadily since the inauguration of the Central Agricultural Experiment Station in 1946. The following table reflects this growth. The guidance workers are included, due to the important role they occupy as the extension arm of ORD.

Year	Administration	Research	Guidance (Extension)	Total
1954	11	95	—	106
1950	38	195	—	233
1957	77	278	417	765
1962	85	539	3,173	3,797
1970	230	856	6,587	7,673

MAJOR RESEARCH FACILITIES

The Office of Rural Development is fortunate in having ten main stations, two branch stations and nine provincial stations that are reasonably well equipped for basic and/or practical research. The Korean government is giving good support to the Rural Modernisation Programme. However, budgetary limitation, with all its ramifications, makes it difficult for ORD to carry out adequately its assigned responsibilities to its full capabilities. Major research facilities are adequate in number and distribution but some are in need of numerous items of equipment, machinery and more supplies. Staff salaries are inadequate to attract and keep the more qualified scientists, technicians, and rural guidance staff. Personnel loss due to better paying jobs in industry, private enterprise and for other reasons is a continuous disturbing problem. In addition to higher salaries, more opportunities for professional improvement (locally and abroad) of research and rural guidance staff is needed and will help to improve the status of these posts and retain staff. ORD has been fortunate in receiving much outside assistance from the USAID, FAO, and other sources. Without this help the present facilities and professional level of staff would be much less adequate. The following pages will outline briefly the research functions of the main and branch stations, their areas of research, as well as several of their notable recent contributions to the rural modernisation programme in Korea.

Institute of Plant Environment

This station conducts research in the areas of (1) chemical, physical and physiological properties of soils, (2) diagnosis and studies of plant nutritional problems, (3) development of new fertiliser mixtures and soil fertility improvement, and (4) development of improved pesticides based on investigations of the physiology and ecology of plant diseases and insect pests. A major undertaking during the past five years, with generous help from an FAO/UNDP project, was the survey and classification of a large portion of the soils of Korea. Breeding of high producing mushrooms and improvement of cultural practices is another top priority research activity.

Commendable results of intensive work by this Station include: (1) a reconnaissance soil survey of the 9.8 million hectares of Korea's land area and a detailed soil survey of 925,000 hectares of cropland, (2) intensive studies on rice breeding to identify varieties resistant to the 19 strains of blast *(Pyricularia oryzoe)*, resulting in the selection of resistant varieties and improved chemical control of this fungus disease, (3) soil fertility studies resulting in increased rice yields using wollastonite in conjunction with nitrogen fertiliser, and (4) a new high yielding mushroom strain '304' which was developed and widely distributed throughout the country. This strain has increased yields by 35%.

Crop Experiment Station

This station occupies 40 hectares of land, has 12 greenhouses and a modern phytotron and is capable of conducting basic research in small grain crops throughout the year. Major emphases are on: (1) breeding superior varieties of rice, wheat, corn, sorghum and soybean, (2) the development of industrial and export crops, and (3) improved cultivation techniques, more efficient cropping systems and intensive land utilisation.

A recent important research contribution was the development of a new rice variety IR-667 in cooperation with the International Rice Research Institute in the Philippines and the College of Agriculture of Seoul National University. This short-stem, blast-resistant variety responds well to heavy fertiliser applications and has demonstrated the ability to increase yields over local varieties by 32%. Three new wheat varieties have been developed through 15 years of intensive breeding work. These varieties show 6 to 32% increase in production over standard local varieties. A new soybean variety, 'Suke No. 36', developed at this station, has shown higher yield over standard varieties and a widespread seed distribution programme is now underway. Improved cultural methods for sweet-potatoes are consistently resulting in increased yields of over 8%.

An international wheat rust nursery, containing 400 wheat varieties from throughout the world, was established in 1970.

Two regional stations, operating in strategic crop production areas, are important institutions working in conjunction with and under close supervision of the director of the station. These are the Honam Crop Experiment Station located in south-west central Korea and the Youngnam Crop Experiment Station established in the important crop area in the south-east central area of Korea. These stations conduct basic and practical research in the same areas as the main crop station. Priority is given to breeding rice and other grains for high productivity, disease resistance and shortened growing season. Attention is also given to solving certain cultivation practices, cropping patterns, pest control, land utilisation, weed control and other problems peculiar to the regions where these stations are located.

Horticulture Experiment Station

All resources of this station are devoted to: (1) improving or breeding new disease-resistant, high producing and better quality varieties of fruit, vegetables and flowers, (2) processing horticulture crops for domestic use and export, and (3) the study of improved cultural practices, labour-saving methods, pest control and intensive crop production techniques.

The Horticulture Station has a record of a wide range of research results which have increased farm income and overall economic development of the rural sector. Breeding and selection experiments have produced outstanding new vegetable varieties such as onion, cabbage and radish, the selection of three new high-producing varieties of hot peppers and a new sweetpear variety, the selection of two tomato varieties for commercial planting and processing, and the selection and breeding of ornamentals and flowers as commercial cash crops. Experimental work in processing has resulted in a wide range of canned, frozen or bottled fruit and vegetable products.

Sericulture Experiment Station

Silk production is an important foreign exchange earning item with great potential for expansion. Research conducted at this station involves all facets of silk production, including: (1) breeding for superior high producing cocoons, (2) selecting high producing mulberry varieties, (3) improved cultural methods, and (4) studies on improved silk processing methods to ensure a higher quality product.

Successful research results include: (1) development of a new silk-worm strain which is capable of increasing silk by 20% over the standard strain, (2) a more efficient cocoon rearing system which is resulting in an increased yield in excess of 4%, (3) more effective insect control in mulberry plantings, resulting in an average increase in yield of leaves by 14%, and (4) intensive studies in more careful and efficient handling of cocoons during the cooking process which promise to produce higher quality silk.

Livestock Experiment Station

Due primarily to the limited land resources of Korea, livestock and poultry production have received less attention than grains and other food crops. The Government is convinced that by maximum utilisation of low potential soils for forage production and by improved breeding of cattle, hogs and poultry it will be possible to greatly increase the amount and quality of animal protein foods.

The ORD Livestock Station staff are conducting research on: (1) the selection, breeding and cultivation of superior types of forage crops, (2) nutritional and management practices, (3) upgrading livestock and poultry by selection and crossbreeding, and (4) the processing and expanded utilisation of poultry and livestock products.

Research results to date in several areas have been quite successful. Crossing of Korean native cattle with imported English beef breeds is resulting in an increase of body weight, from the F_1 offspring, of 13% over the native cattle at 24 months of age. Studies on early weaning, improved feeding, and other good animal husbandry practices have demonstrated that hog production can play an important role in providing additional food and cash income for Korean farmers. Alfalfa planting trials have proven that this highly nutritious forage crop can be economically grown under Korean conditions when proper cultural practices are followed. Experiments on the selection of superior native grasses and crosses between these and imported species are giving encouraging results in the development of long season grazing and hay crops.

Veterinary Research Laboratory

In line with the expanding livestock and poultry enterprises, ORD is giving priority attention to disease prevention and control. This well equipped facility is directing its efforts to: (1) research on ways and means of preventing and/or controlling livestock epidemics or serious outbreaks of disease, (2) the manufacture of veterinary biologicals, and (3) diagnostic services to government and private veterinary practitioners.

The use of the modern fluorescent antibody and spectrographic electron-microscopic technique and use of other sophisticated equipment is proving of great value in accurately diagnosing diseases and developing more effective biologicals. Provincial veterinary specialists receive regular training at this laboratory. They in turn conduct livestock disease surveys for the laboratory and utilise the diagnostic services of its staff. This facility also has the only completely equipped and staffed poultry research laboratory in Korea.

The Institute of Agricultural Engineering and Utilisation

The Institute is located at the main ORD compound and in April 1970 moved into a new modern building. This facility is considerably handicapped in providing maximum service due to insufficient equipment and machinery. Areas of research cover the entire range of farm machinery for rice and other food crops. Ways and means for the effective utilisation of ground water and other sources of water pertaining to farm operations are receiving priority attention. Mechanical and chemical milling of rice, barley and other grains is under study. Improved techniques and methods of processing and preserving farm products are other research responsibilities.

This institute has a long record of providing practical services and improved items of machinery and equipment for the rural populace. Staff provide teaching services and laboratory facilities for the 4-H Club farm machinery classes which are conducted throughout the year. A power-propelled potato harvester designed at this institute resulted in a harvesting performance 2.7 times faster than the hand method. Successful research was conducted to condense and preserve a wide variety of fruit juices for local consumption and export. A mole drainage driller perfected by agricultural engineers, to be used in the desalinisation of reclaimed tide land areas, reduces the cost of drilling by 50% and the time saved over the winch type drill by 200%. More efficient grain drying equipment, improved plows and other farm equipment, soil and water conservation methods, and improved irrigation systems and methods are other contributions of this facility.

Alpine Experiment Station

This station is located in the mountainous north-east province of Korea. Research is conducted on agriculture and livestock problems peculiar to this hilly region. These include: (1) breeding of disease resistant, high yielding potato varieties, (2) breeding new vegetable varieties and improvement of cultivation practices, (3) selection of superior rice and corn varieties for high elevation, (4) cattle and sheep development and (5) selection of forage crops for higher elevations.

Cattle feeding trials demonstrated the advantage of hybrid animals and proved that good feeding practices were economically feasible. These cattle had a 25% higher body weight and 27% higher dressing percentage which resulted in a 64% increase in gross profit.

Hybrid corn trials resulted in widespread dissemination of improved seed, higher yields and increased hectarage. Experiments with alfalfa and imported grasses are showing promise that with proper care forage crops can become widespread in use in this area. Successful potato experiments include germination control of seed potatoes and the development of varieties resistant to mosaic and other diseases.

Cheju Experiment Station

Located on the Southern Island Province, this Station handles agriculture and livestock problems of importance to this island. The mild south temperate climate and extremely porous volcanic soils of this province offer a challenge to research workers. Areas of research include: (1) improvement and expansion of a potentially large cattle population, (2) forage crop selection, importation and improvement, (3) improvement of vegetables and fruits (some of which are sub-tropical varieties).

Experiments on crossbreeding native cattle with English breeds, and fattening trials using the resulting F_1 offspring, have been uniformly successful. The results showed a 40–60% higher gross income from these experiments. Artificial insemination services from Santa Gertrudis bulls, provided to cattle owners, have been widely accepted and high quality beef is a regular export commodity to markets on the mainland. Alfalfa, brome, Harding, Bahia, Dallis, red clover, white clover and other high quality forage crops are being grown successfully for forage, seed production, and demonstration purposes. Studies on improved cultural practices of vegetables are of importance to Cheju. An experiment on controlled open field cultivation of tomatoes proved that the growing season of this crop and other vegetables can be extended by several months. Vinyl-house production of vegetables and flowers also is receiving attention as a possible means of producing year-round high income crops.

Institute of Agricultural Economics

The research responsibilities of this institute are: (1) to conduct studies and make recommendations on the improvement of farm management and resources, (2) to make economic analyses of special farm income projects, (3) to conduct studies on improving the marketing of agricultural products, and (4) to survey the feasibility of proposed regional agriculture projects.

Recently completed surveys of considerable importance include: (1) an exhaustive analysis of mushroom production in Korea, (2) a detailed study on the economically optimum sizes and structures for Korean cattle and dairy farms, and (3) a hog marketing survey covering the four hog markets in the Seoul area.

PORD Stations

Each of the nine Provincial Office of Rural Development (PORD) Directors has under his supervision and control a Research/Experiment Station. These stations vary considerably in size. Some are well equipped and most are staffed by capable technicians. Others lack needed physical facilities. Financial support for buildings, land, equipment, and supplies comes from the provincial government.

Therefore, the size, scope of operations, and resultant work output is influenced considerably by the amount of budgetary support. Salaries of station personnel are paid from the national budget. Personnel changes or turnover of staff are frequent due to the reasons previously mentioned.

The PORD stations are extensions of the main ORD research stations and do not conduct basic research. Their main functions are: (1) to conduct seed and plant adaptation trials and seed and plant multiplication, (2) to conduct practical sericulture research involving all phases of sericulture, (3) to carry out improved livestock breeding trials, provide artificial insemination services, forage crop experiments and livestock multiplication, and (4) through the veterinary, furnish disease diagnostic services to farmers, conduct surveys involving outbreaks of diseases and provide sanitary services to livestock owners.

These stations have a long history of successful operation and are an important means of 'proving' research results at the farmer level. Provincial trials of the new rice variety IR-667 were successfully completed and the stations are now multiplying this variety for future distribution. Hybrid corn, improved soybean, sorghum, and several forage crop varieties were proven and released to farmers. Hundreds of fertiliser and pesticide trials are conducted annually. As resources permit, purebred cattle, hogs and poultry breeding stock are sold to the farmers for upgrading local breeds or to produce purebred offspring. Staff training and farmers' field days for demonstration purposes are other important functions of these installations.

DISSEMINATION OF RESEARCH RESULTS

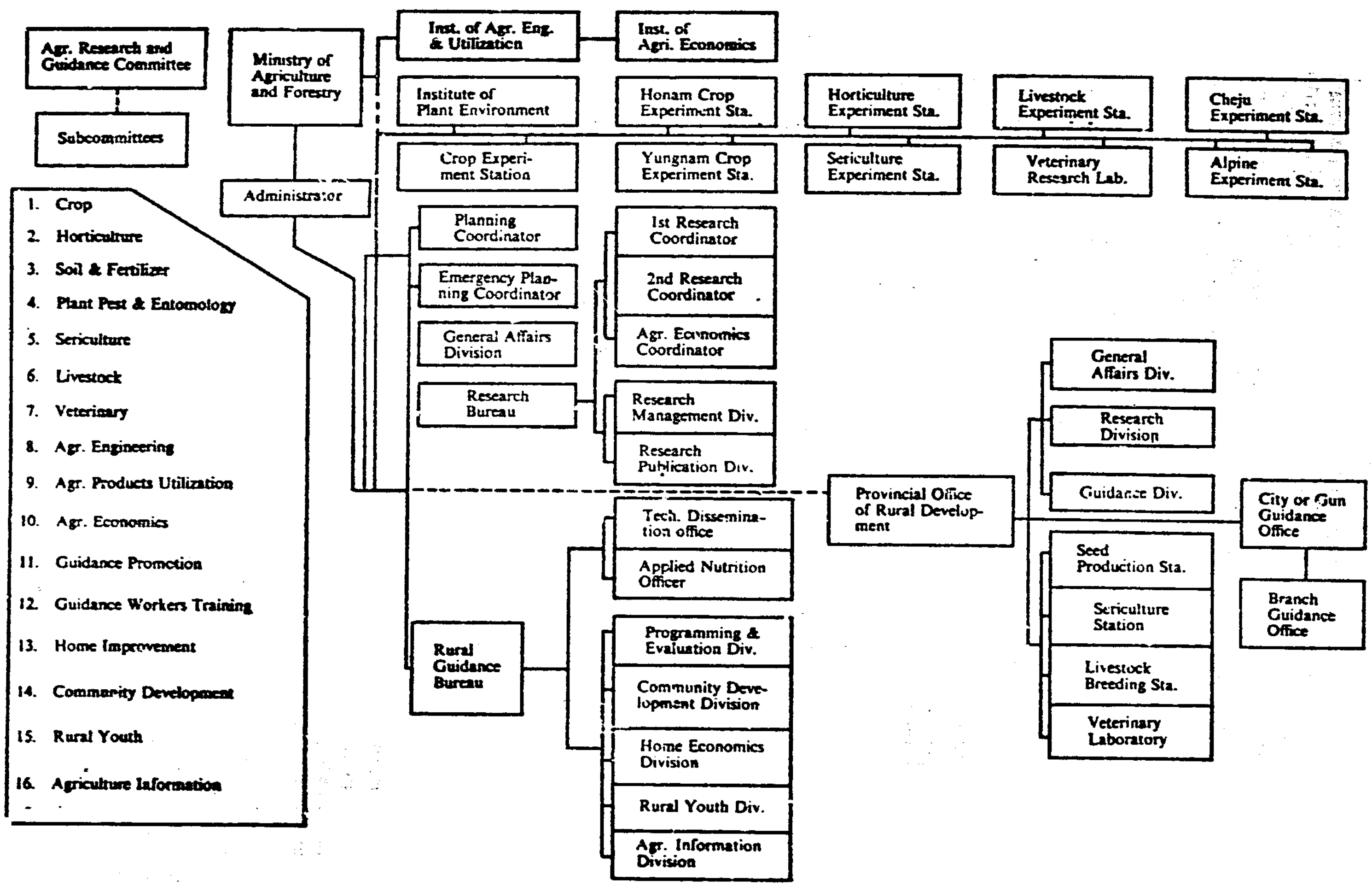
In conclusion, a short statement on the role of the Rural Guidance Service in the diffusion process is in order.

Research findings, demonstration results, development of improved crop varieties, fertiliser and pesticide trials, etc. are of very little value to the farmer if the needed information is not made available to him on a timely and understandable basis.

The extension service in Korea has been a most important influence in the diffusion of agriculture knowledge to rural people. The overall objective of the extension service, as it was established in 1957, is to increase the productivity of farms and farm income through educational and action programmes. In 1962 various functions including community development, rural youth and extension were combined for better efficiency and ease of administration into a Rural Guidance Bureau. This bureau contains five divisions: Programming and Evaluation, Agriculture Information, Rural Youth, Home Economics and Community Development.

Educational methods used by staff of the Guidance Bureau to carry information to the farmers cover the full range of facilities available. Publications (leaflets, bulletins, newspapers), posters, charts, radio broadcasts, films, slides and field audio-visual mobile units are all part of the work of the Information Center in Suwon.

More than six thousand Province Rural Guidance Workers, under the direction of PORD Director's Guidance Division, use every means at their disposal to transmit research results to farmers. Demonstrations are the most important guidance teaching devices. Other methods such as farmers' meetings, farm visits, office contacts, publications, etc. play a major role in the dissemination of information. Village Development Councils, working under the guidance and supervision of the guidance agent, help organise cooperative groups and plan educational programmes.


Agr. Research and Guidance Committee
Subcommittees
Ministry of Agriculture and Forestry
Administrator
Inst. of Agr. Eng. & Utilization
Inst. of Agri. Economics
Institute of Plant Environment
Honam Crop Experiment Sta.
Horticulture Experiment Sta.
Livestock Experiment Sta.
Cheju Experiment Sta.
Crop Experiment Station
Yungnam Crop Experiment Sta.
Sericulture Experiment Sta.
Veterinary Research Lab.
Alpine Experiment Sta.
1. Crop
2. Horticulture
3. Soil & Fertilizer
4. Plant Pest & Entomology
5. Sericulture
6. Livestock
7. Veterinary
8. Agr. Engineering
9. Agr. Products Utilization
10. Agr. Economics
11. Guidance Promotion
12. Guidance Workers Training
13. Home Improvement
14. Community Development
15. Rural Youth
16. Agriculture Information
Planning Coordinator
Emergency Planning Coordinator
General Affairs Division
Research Bureau
1st Research Coordinator
2nd Research Coordinator
Agr. Economics Coordinator
Research Management Div.
Research Publication Div.
Tech. Dissemination office
Applied Nutrition Officer
Rural Guidance Bureau
Programming & Evaluation Div.
Community Development Division
Home Economics Division
Rural Youth Div.
Agr. Information Division
Provincial Office of Rural Development
General Affairs Div.
Research Division
Guidance Div.
Seed Production Sta.
Sericulture Station
Livestock Breeding Sta.
Veterinary Laboratory
City or Gun Guidance Office
Branch Guidance Office

Agricultural Research and Development Budgets

Table AII-1: Public R & D Expenditures for Agriculture, Forest and Fishery by Subject and Organization

Subject	Organization	1970	1971	1972
	Total	3,954,921	4,909,197	5,700,406 1/
	Office of Rural Development	1,000,831	1,420,690	1,780,834
Crop	Crop Experiment Station	182,834	220,349	223,706
	Honam Crop Exp. Station	37,680	49,666	51,115
	Yungnam Crop Exp. Station	27,852	43,001	61,752
	Chezu Crop Exp. Station	37,509	41,319	47,096
	Alpine Exp. Station	61,710	73,353	85,847
	Radiation Res.Inst. in Agriculture	176,301	169,359	162,294
Horti-culture	Horticultural Exp. Station	104,671	135,271	128,551
Seri-culture	Sericultural Exp. Station	65,282	73,113	77,661
Live-stock	Livestock Exp. Station	132,823	148,741	157,480
	Veterinary Res.Lab	138,803	128,147	151,450
Forest	Forest Exp.Station	338,404	374,065	402,296
	Inst. of Forest Genetics	88,459	128,900	135,199
Fishery	Nat.Fisheries Res. and Dev. Agency	339,404	374,065	402,296

Table AII-1 continued on next page

Table AII-1 contd.

Subject	Organization	1970	1971	1972
	Fishery Inspection Office	95,761	108,084	120,409
Chemical	Inst. of Plant Environment	144,394	205,795	219,639
Management	Inst. of Agr. Management	36,426	63,865	87,201
Manufacturing	Inst. of Agr. Eng. and Utilization	92,160	92,214	109,261
	Tec. Res. Inst. (Offi. of Nat.Tax Adm.)	52,659	53,227	52,360
	Central Res.Inst. (Office of Monopoly)	203,116	206,342	259,248
Inspection 2/	Agr. Prod. Inspection Office	447,132	605,636	783,009
	Seoul Silk Conditioning House	55,917	75,167	79,656
	Pusan Silk Conditioning House	47,470	61,273	63,460
	Nat. Inst. for Agr. Mat.	47,322	57,555	58,586

1/ Approximately 20 percent or 1.2 billion won expended on rural development.

2/ Should not be counted in research budget.

Table AII-2: Other R & D Expenditures for Agriculture, Forestry & Fisheries Sector in Korea, 1970

Unit: One Thousand Won

Classification	R & D Expenditures
Private Research Institutes	$ 10,269
Universities and Colleges	31,039
Private Enterprises	77,441
Total	$118,749

Source: MOST, 24 August, 1972

Table AII-3: Research Budget for ORD. 1972

Item	Won	Won	Percent of Total
Professional Staff (Not Admin.)		299,711,000	17.2
Salaries	246,647,000		
Allowance	53,064,000		
Labor		234,321,000	13.4
Regular	87,907,000		
Temporary	146,414,000		
Travel Costs		77,022,000	4.4
Vehicle Costs		15,045,000	.9
Materials - Research		272,916,000	15.6
Repairs		62,071,000	3.6
Commission	32,081,000		
Big Repairs	29,990,000		
Public Fare & Tel. Inst.		23,273,000	1.3
Printing		46,467,000	2.7
Equipment - New		58,134,000	3.3
Equipment Repair		3,996,000	.2
Facilities		313,622,000	17.9
Construction - New	295,573,000		
Additions	8,528,000		
Assistance to PORDs	9,521,000		
Fuel		32,336,000	1.9
Rent		3,993,000	.2
Clothing		1,463,000	.1
Meal Services, etc.		2,531,000	.1
Taxes		14,800,000	.8
Land Purchases		32,247,000	1.8
Feed - Livestock		54,066,000	3.4
Allowance for Special Guests		4,260,000	.2
International Travel (17 Persons)		2,970,000	.2
International Coop. (FAO) Rok Funds		30,000,000	1.7
Self-Help Agencies, PORDs Contribution		146,678,000	8.4
Support for Exp. at Farmer Plots		2,400,000	.1
Rewards		1,200,000	.1
Information and Service		1,296,000	.1
Support of COA Exp.Service		7,040,000	.4
Compensation		630,000	
USAID - ROK Fund Support		2,500,000	.1
Total		1,746,988,000	
Estimated salary and allowances government position one or higher		5,000,000	

Appendix III

Alumni of COA/SNU Presently Residing in Foreign Countries furnished by Dean Hyun Koo Pyo, COA/SNU

Table AIII-1: Number of COA/SNU Alumni by Department in Foreign Countries

Department	U.S.A.		Other		Course		Total
	M.S.& Trainee	Ph.D.	M.S.& Trainee	Ph.D.	M.S.& Trainee	Ph.D.	
Dept. of Crop Science	2	11	3	2	5	13	18
Dept. of Forestry	1	2	1		2	2	4
Dept. of Animal Science	3	4		1	3	5	8
Dept. of Agri. Engineering		3	2	2	2	5	7
Dept. of Agri. Chemistry	6	10	4	1	10	11	21
Dept. of Agri. Economics	2	8	4		6	8	14
Dept. of Agri. Biology	1	13	5	3	6	16	22
Dept. of Sericulture	1	2	5		6	2	8
Dept. of Agri. Home Economics	1	1	1		2	1	3
Dept. of Veterinary Medicine	35	8	8	3	43	11	54
Dept. of Agri. Education	2		1	1	3	1	4
Dept. of Horticulture	2	7	1	1	3	8	11
Dept. of Food Technology							
Dept. of Forest Products							
Total	56	69	35	14	91	83	174

Table AIII-2: List of Alumni in Foreign Countries

Department	Name	Country	Degree
Dept. of Crop Science	Lee, Dong A.	U.S.A.	
	Lee, Ke Hong	U.S.A.	
	Choe, Sang Jin	U.S.A.	
	Chae, Young Am	U.S.A.	Ph.D.
	Kim, Sang Jin	U.S.A.	M.S.
	Lee, Jung Myung	U.S.A.	Ph.D.
	Lee, Chooung Il	U.S.A.	Ph.D.
	Park, Hyo Keun	U.S.A.	Ph.D.cand.
	Yoo, Kyung Sang	U.S.A.	Ph.D.cand.
	Kim, Du Kyung	U.S.A.	
	Lee, Chung	U.S.A.	Ph.D.
	Pyun, Jong Ui	U.S.A.	
	Ahn, Soo Hyun	U.S.A.	Ph.D.cand.
	Han, Sang Joo	U.S.A.	Ph.D.
	Kim, Pill Joo	U.S.A.	Ph.D.
	Im, Seung Man	U.S.A.	
	Kim, Kwang Sin	U.S.A.	
	Jang, Se Yun	U.S.A.	
	Lee, Jae Sun	U.S.A.	
	Lee, Jong Yun	U.S.A.	
	Kim, Jae Ho	U.S.A.	
	No, Seung Moon	U.S.A.	
	Kim, Byung Dong	U.S.A.	
	Park, Soon Jea	U.S.A.	Ph.D.
	Sung, Il Jang	Japan	
	Kim, Dong Ho	Chili	
	Heo, Moon Do	Japan	Ph.D.cand.
	Jung, Tae Gyun	U.S.A.	
	Kim, Kwang Sin	U.S.A.	
	Jung, Jae Hun	U.S.A.	
	Kim, Hea Young	U.S.A.	Ph.D.
Dept. of Crop Science	Jang, Oh Hyun	U.S.A.	
	Kim, Sang Jin	U.S.A.	
	Park, Chan Ho	U.S.A.	
	Joo, Jin Bae	Canada	
	Jang, Duk Sun	Canada	

Table AIII-2 contd.

Department	Name	Country	Degree
Dept. of Forestry	Kang, Ke Won	U.S.A.	Ph.D.
	Hong, Sung Gak	U.S.A.	Ph.D.
	Son, Sung In	U.S.A.	M.S.
	Ahn, Suk Whan	Canada	M.S.
Dept. of Animal Science	Kim, Hyun Yuk	U.S.A.	Ph.D.
	Lee, Woo Bang	U.S.A.	Ph.D.
	Yoo, Byung Hyun	Austral.	Ph.D.
	Min, Byung Sung	U.S.A.	Ph.D.
	Ji, Kyu Man	U.S.A.	M.S.
	Park, Hong Suk	U.S.A.	M.S.
	Yang, Ho Seung	U.S.A.	Ph.D.
	Lee, Bok Ho	U.S.A.	M.S.
Dept of Agri. Engineering	Jung, Tae Sang	U.S.A.	Ph.D.
	Lee, Bong Kug	U.S.A.	Ph.D.
	Lee, Sang Myung	U.S.A.	Training
	Kim, Kyu Whan	Canada	Ph.D.
	Kim, Sung Sam	Canada	Training
	Lee, Yong Kog	Phili.	Training
	Youn, Suk Tong	Nether.	
Dept. of Agri. Chemistry	Lee, Suk Young	U.S.A.	Ph.D.
	Park, Gui Hee	U.S.A.	Ph.D.
	Kim, Jae Kyong	U.S.A.	Ph.D.
	Kim, Myung Chong	U.S.A.	Ph.D.
	Doh, Wun Heu	U.S.A.	Ph.D.
	Lee, Chang Nai	U.S.A.	M.S.
	Lee, Sam Huy	U.S.A.	M.S.
	Lee, Young Chun	U.S.A.	M.S.
	Jung, Hun	U.S.A.	M.S.
	Park, Nae Jeong	U.S.A.	Ph.D.
Dept. of Agri. Chemistry	Jung, Koo Hung	U.S.A.	Ph.D.
	Pyun, Si Myung	U.S.A.	Ph.D.
	Maeng, Il Young	U.S.A.	Ph.D.
	Lee, Hong Won	U.S.A.	Ph.D.
	Choe, Young Nak	U.S.A.	Ph.D.
	Lee, Ki Ho	U.S.A.	M.S.
	Kim, Woo Jung	U.S.A.	M.S.
	Park, Khan Wha	Germany	Ph.D.
	Kim, Joong Jung	Canada	M.S.

Table AIII-2 contd.

Department	Name	Country	Degree
	Kim, Young Suh	Canada	M.S.
	Park, Youn Hee	France	M.S.
	Han, Kang Waun	Phili.	M.S.
Dept. of Agri. Economics	Yoo, Kang Hee	U.S.A.	Training
	Lee, Sung Woo	U.S.A.	Ph.D.
	Kim, Jung Ho	U.S.A.	Ph.D.
	Sull, In Joon	U.S.A.	Ph.D.
	Lee, Kyung Won	U.S.A.	Ph.D.
	Hue, Sin Haeng	U.S.A.	M.S.
	Choe, Yang Boo	U.S.A.	Ph.D.
	Sung, Bae Young	U.S.A.	Ph.D.
	Kim, Sak Eun	U.S.A.	Ph.D.
	Lee, Jung Chan	U.S.A.	Ph.D.
	Kim, Hoo Kyun	Thailand	M.S.
	Lee, Jae Han	Thailand	Training
	Eoum, In Ho	Canada	Training
Dept. of Agri. Biology	Yun, Jong Oh	Japan	Ph.D.cand.
	Jang, Mu Woong	Japan	Ph.D.cand.
	Oh, Seung Whan	U.S.A.	Ph.D.cand.
	Kim, Sung Whan	U.S.A.	Ph.D.
	Cho, Han Yong	U.S.A.	
	Chou, Byung Moon	U.S.A.	Ph.D.
	Poo, Kyung Saeng	U.S.A.	Ph.D.
	Son, Chung Yull	U.S.A.	Ph.D.
	Moon, Kyung Sam	U.S.A.	M.S. part.
Dept. of Agri. Biology	Whang, Ki Sup	U.S.A.	Ph.D.cand.
	Bok, Sung Hae	U.S.A.	Ph.D.cand.
	Jang, In Kug	U.S.A.	Ph.D.cand.
	Whang, Joo Kang	U.S.A.	Ph.D.cand.
	Park, Young Chul	U.S.A.	Ph.D.cand.
	Cho, Jong Kun	U.S.A.	Ph.D.cand.
	Nam, Yun Chul	U.S.A.	Ph.D.cand.
	Oh, Jung Haeng	Phili.	M.S.cand.
	Lee, Young In	England	M.S.cand.
	Kim, Se Pyung	Austral.	M.S.cand.
	Ahn, Dae Sik	Denmark	Training
	Lee, Tae Ho	Denmark	Training
	Lee, Jung Wooun	Austria	Ph.D.cand.

Table AIII-2 contd.

Department	Name	Country	Degree
Dept. of Seri-culture	Moon, Jae Yu	Japan	M.S. cand.
	Cho, Jang Ho	Japan	M.S. cand.
	Kim, Ke Myung	Japan	M.S. cand.
	Joo, Young Chul	U.S.A.	Ph.D.cand.
	Kim, Myung Cho	U.S.A.	M.S. cand.
	Lee, Sang Won	U.S.A.	M.S. cand.
	Kim, In Whan	England	M.S. cand.
	Kim, Ki Booung	Canada	M.S. cand.
Dept. of Veterin-ary Medicine	Kim, Moon So	U.S.A.	M.S. cand.
	Kim, Sang Nam	U.S.A.	Ph.D.
	Kim, Sung Boung	U.S.A.	
	Kim, Young Du	U.S.A.	
	Kim, Jin Sun	U.S.A.	
	Kim, Jin Soo	U.S.A.	
	Kim, Hyun Young	U.S.A.	
	Moon, Hyung In	U.S.A.	
	Moon, Young Suk	U.S.A.	Ph.D.
	Park, Dae Keun	U.S.A.	
	Eo, Hyung Sun	U.S.A.	Ph.D.
	Oh, Young Gak	U.S.A.	
	Oh, Hee Kohn	U.S.A.	Ph.D.
	Wang, Gill Wooun	U.S.A.	
	Lee, Ki Pung	U.S.A.	Ph.D.
	Lee, Si Baek	U.S.A.	
	Lee, Il Wha	U.S.A.	
	Cho, Jung Hyun	U.S.A.	
	Kim, Dong Sin	U.S.A.	
	Park, Jong Soo	U.S.A.	M.S.
	Son, Soo Wooung	U.S.A.	
	Jang, Hyo	U.S.A.	
	Yoon, Sang Nai	U.S.A.	
	Cho, Han Chul	U.S.A.	Ph.D.
	Park, Min Sik	U.S.A.	
	Haa, Byung Nai	U.S.A.	
	Lee, Myung Wooun	U.S.A.	
	Sin, Sang Jae	U.S.A.	
	Jung, Young Sup	U.S.A.	
	Choe, Chang Joo	U.S.A.	

Table AIII-2 contd.

Department	Name	Country	Degree
	Cho, Byung Ryul	U.S.A.	Ph.D.
	Ji, Hung Min	U.S.A.	
	Han, Il Kang	U.S.A.	
	Han, Kak	U.S.A.	
	Kim, Young Du	U.S.A.	
	Sim, Young Chun	U.S.A.	
	Yoon, Sang Dae	U.S.A.	
	Koh, Kang Il	U.S.A.	
	Lee, Young Sup	U.S.A.	
	Lee, Jae Hyung	U.S.A.	
	Lee, Hyung Keun	U.S.A.	
	Cho, Du Youn	U.S.A.	M.S. cand.
	Han, Ui Saeng	U.S.A.	
	Heu, Kyu Kap	Canada	
	Choe, Han Pyo	Canada	
	Lee, Kap Jae	Canada	
	Jeon, Sang Jung	Canada	
	Kim, Sang Jin	Canada	
	Park, Chei Yup	Germany	
	Jang, In Ho	Austrail	Ph.D.cand.
	Kwon, Jong Kuk	Austrail	Ph.D.cand.
	Lee, Joon Sup	Austrail	Ph.D.cand.
	Jung, Yun Sup	England	
Dept of Agri. Education	Kim, Jung Il	U.S.A.	M.S.
	Lee, Yong Whan	U.S.A.	Training
	Lee, Jung Gill	Japan	M.S.
	Hong, Ki Yong	Phili.	Ph.D.
Dept. of Agri. Home Economics	Kim, Yang Ja	U.S.A.	Ph.D.cand.
	Park, Mi Suk	U.S.A.	M.S. cand.
	Jang, Sooun Ja	Canada	M.S. cand.

Appendix IV

Some Tentative Personnel Suggestions for Phase I Planning Team

Name	Location	Specialty
Henry M. Beachell	IRRI	Rice
G. Beck	Kansas	General
R.L. Bernard	Illinois	Soybeans
Glen Burton	ARS-USDA	Cereals-Forages
Robert Chandler	Former IRRI (if available) Now in Taiwan	Rice (General)
James Cobble	COA/SNU	General
Lloyd Crowder	IETA	Legumes
Samuel Freiberg	IRI	
John E. Grafius	Michigan	Barley
S.K. Hahn	IETA	Barley, Wheat
Dale Harpstead	Michigan	Cereals
Gary Harrington	IRI	
M.H. Heu	COA	Rice
E.A. Hockett	Montana	Barley
J. Krider	Purdue	Animal Husbandry
Ray Moore	South Dakota	Forages-Livestock
Louis M. Roberts	Rockefeller	Soybeans-Legumes
Mike Tesar	Michigan	Forages
Orville Vogel	ARS-USDA (Washington State)	Wheat

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