SOME ECONOMIC ASPECTS OF UPLAND DEVELOPMENT IN KOREA

by

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A Research Paper

Submitted in partial fulfillment of the
requirements (Under Plan B) for the
degree of

MASTER OF SCIENCE

Department of Agricultural Economics

Michigan State University

1972

ACKNOWLEDGEMENTS

I would like to express my deep respect and gratitude to my advisor Dr. Warren H. Vincent, who has helped me above and beyond the call of duty. Without his help and guidance, this research would not have been possible.

Appreciation is also extended to Dr. James D. Shaffer and Dr. Maurice D. Weinrobe, my research committee, who have been very kind and helpful at all times.

A special word of thanks is due to Mrs. Judy Stephenson and Mr. Tom Zambetis for their work at the computer center.

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CHAPTER I

INTRODUCTION

Korea is a land-short economy faced with a very high population density and low land cultivation density and high rates of migration from farm to urban areas with rapid urbanization.[1] Therefore, agricultural land is one of the valuable resources for the Korean economy.

Shortage of land has been one of the major limitations of production in the Republic of Korea in trying to produce enough food to supply its expected demands. Population growth is one of the major factors in determining this demand for food. In 1961, the total population was about 25 million. It increased to 28 million in 1965, and by 1968 had risen to 31 million. By the end of 1971, the population was expected to about 33 million. Population grew at an annual rate of 3.0 percent in 1961, but the rate is expected to decline to 2.2 percent in 1971.[2] Currently, about 60.0 percent of the population still derives its likelihood from agriculture. Agriculture sector contributes about 28.4 percent of the GNP.

Geography contributes substantially in determining the pattern of South Korea's agriculture. The mountainous topography is one of the limiting factors for agricultural development, leaving only approximately 22 percent of the land area for cultivation. About 60 percent of the country is mountainous and another 10 percent committed for other uses.

There is evidence that for the nearly three decades prior to the Korean War, the arable land base of the present Republic remained relatively constant.

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[1] Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, July 1, 1972, p. 11.

[2] Changing Food Consumption Pattern in The Republic of Korea, U.S. Department of Agriculture, Economic Research Service (ERS), Foreign 306, p. 3.

In the decade immediately after the Korean War there was an approximate 8 percent decline from the former level of arable land.[3]

As the Korean economy develops rapidly the need for agricultural land development is also increasing. Rapid growth of the non-agricultural sector high rate of urbanization and industrialization process, demanding more land for urban housing, factories, road construction, public facilities, etc. Because of these demands, the total area of existing cropland will be reduced unless present area is supplemented by new land development. This would mean to give primary attention to the potential for the development of upland development in which current levels of productivity are low. Therefore, upland development is of fundamental importance.

Several studies have been made in analyzing the upland development activities in Korea. In recent years, Park[4] has made a study on upland development activities in Korea with special reference on upland development programs in 1962 through 1967. The objectives of his study were as follows:

1. To assess the land development potentials and identify the areas where holding of underdeveloped land is large.
2. To measure the amount and kind of new lands developed during the First Five-Year Plan, and the characteristics of farms participating in development.
3. To study the patterns of new upland uses and the extent to which the new lands contribute increased agricultural production and farm income.
4. To identify the factors restricting land development activities in the area where the holding of underdeveloped lands is large.
5. To study the extent to which land development activities contribute to the transformation of subsistence farm organization into commercial farming.

More recently, a linear programming analysis was made by the Korean Agricultural Sector Study[13] (KASS) to determine the upland cropping pattern which would maximize

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[3] Warren H. Vincent and Kim Byeong Do, "Upland Development in Korea." Working Paper No. 3, Michigan State University, March 1972, p. 1

[4] Jin Hwan Park, "An Economic Analysis of Land Development Activities in Korea." Department of Agricultural Economics, College of Agriculture, Seoul National University, 1969.

the discounted net cash flow on the 85,000 hectares of land with a slope of less than 10 degrees. The assumption that KASS made was 1965-69 technology and 1969 prices, with development costs in addition to operating costs, unpaid family labor for development of land, and 1969 estimate of available farm labor. Haley[5] reported on upland development using regression analysis. Vincent and Kim's contributed working paper to the KASS study concentrated on the supply aspects of upland development and attempted to specify optimum use of those resources considered most limiting for a land development program.

The purpose of this study is to extend the analysis of Vincent and Kim by redefining the model to incorporate new data which have become available since their work.

The fundamental differences between the previous study and the immediate one are summarized as follows:

Vincent-Kim Study	This Study
1. Upland classified to potential use by region.	1. Same assumption on land availability and potential.
2. Study restricted to land with slope less than 9 degrees.	2. Same assumption with regard to excluded land.
3. Available (surplus) labor treated as a constraint to land development.	3. Labor constraint omitted.

[5]Haley, W. J. in "An Analysis of New Land Development in Korea" by R. Barlowe, W. Haley, B. D. Kim, B. S. Kyu, and W. H. Vincent, KASS Special Report No. 3, Agricultural Economics Research Institute, MOAF, Seoul, Korea, 1972.

Vincent-Kim Study	This Study
4. Linear programming model designed to yield solutions for individual regions independently. Government subsidy and policies to restrict area of specific crops set at regional level.	4. Linear programming model designed for national answer with regional constraints restricted to land and regional capital.
5. Objective function was 20 year net cash flow computed with constant prices and crop yields.	5. Objective function computed as before except assume changing yields and prices as projected by the KASS team.
6. Alternative solutions based on comparing 1969 with 1970 price levels.	6. Three alternative price levels were considered as specified in the final report of the KASS Research team.

By considering regional climatic differences, different cropping systems and degree of land slope, 92 different activities were defined in the new linear programming model. These activities for two classes of land follow: Class I land (slope less than 5 degrees) for grain crops and vegetables; and Class II land (slope from 5 to 9 degrees) for fruit crops, vegetables and mulberries.

This study is organized into three parts. In the first part dealing with the general background of upland development the problems and the situations (Chapter II). The second part specifies the linear programming model with the appropriate assumptions, alternatives, constraints, and the objective function (Chapter IV). The final part will present the results of the analysis and their interpretions.

CHAPTER II

UPLAND DEVELOPMENT IN KOREA

The land of the Republic of Korea is about 9.8 million hectares, of which 2.3 million hectares are in farmed cropland. Nearly 6.7 million hectares have been classified as forest (Table 1). Broadly speaking, this includes 321 thousand hectares in "convertible forest", 5.9 million in "reserved forest", and 425 thousand hectares in "other forest land" (Table 2).

South Korea consists of nine provinces: Kyeonggi Do, Gamweon Do, Chungcheon Nam Do, Chungcheon Bug Do, Gyeongsang Bug Do, Gyeongsan Nam Do, Jeolla Bug Do, Jeolla Nam Do, and Jeju Do, with three basic cropping systems. Upland, single cropping paddy, and double cropping paddy (Figure 1.1). The 321 thousand hectares of convertible forest is distributed over the upland region, single cropping region, and double crop region with 81 thousand hectares, 74 thousand hectares, and nearly 166 thousand hectares respectively.[6]

Rather than treat the three regions (upland, single crop and double crop) as homogeneous area , it was decided to further sub-classify the upland and single crop region to account for different adaption of individual crops. Ganweon Do province was excluded from the analysis because it was determined that there was no Class I or Class II land available for further development. Therefore, only eight provinces were chosen for this analysis.

Based on Vincent's report and his adjustment[7] it was decided that 200 thousand hectares of land potentially available for development with about

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[6] Warren H. Vincent and Kim, Byeong Do, op. cit. p. 5.

[7] Ibid, p. 6.

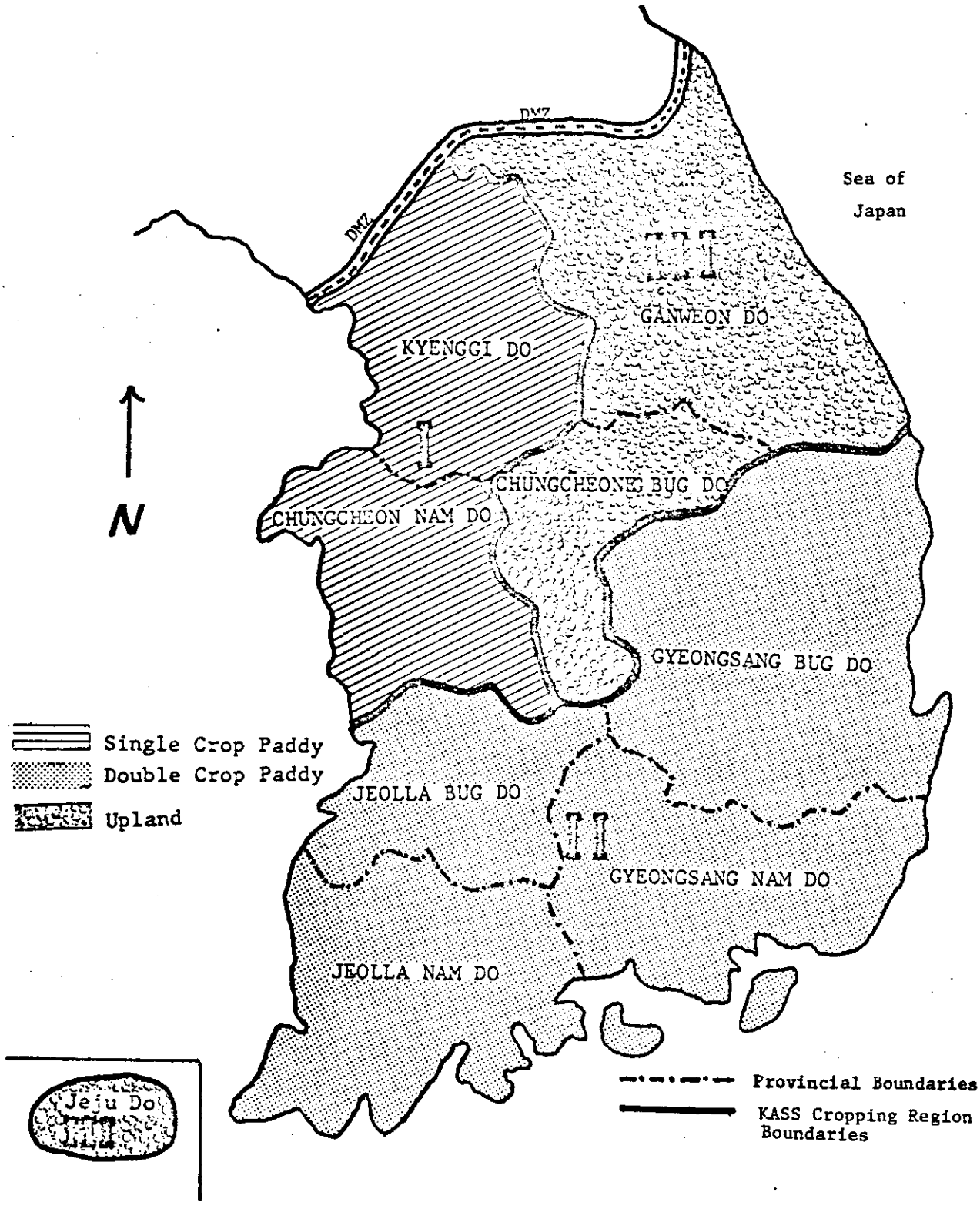

Figure 1.1. Provincial and Cropping Region Boundaries of Korea

Table 1. Land Area. Total, Forest and Other, by Province and Region, Korea 1969.

	Total (Ha.)	Forest (Ha.)	Other (Ha.)
I. Upland			
a. Ganweon Do	1,671,200	1,307,664	363,536
b. Chungcheon Bug Do	743,660	530,734	212,926
c. Jeju Do	182,960	118,902	64,058
Sub Total	2,597,820	1,957,300	640,520
II. Single Crop			
a. Seoul	1,095,770	638,725	457,045
b. Kyeonggi Do	869,920	512,616	357,304
c. Chungcheon Nam Do	61,310	20,291	41,019
Sub Total	2,027,000	1,171,632	855,368
III. Double Crop			
a. Bosan	1,979,780	1,427,583	552,197
b. Jeolla Bug Do	1,194,760	833,905	300,855
c. Jeolla Nam Do	805,090	498,088	307,002
d. Gyeongsang Bug Do	1,205,980	776,291	429,689
e. Gyengsang Nam Do	37,320	21,304	16,016
Sub Total	5,222,930	3,557,171	1,665,759
Total	9,847,750	6,686,103	3,161,647

Source: Survey Report on Classification of Mountain Utilization 1970, Office of Forestry.

Table 2. Distribution of Forest Land to Convertible Forest, Reserved Forest and Other Forest Area, Korea, by Province and Region, 1969. (in Ha)

	Total Forest	Convertible Forest 1/	Reserved Forest	Other Forest
I. Upland				
a. Ganweon Do	1,307,664	1,948.2	1,227,448.5	78,267
b. Chungcheon Bug Do	530,734	10,772.6	497,197.9	22,763
c. Jeju Do	118,902	68,033.0	39,479.0	11,390
Sub Total	1,957,300	80,753.8	1,764,128.4	112,420.8
II. Single Crop				
a. Seoul	638,725	32,098.5	523,489.8	83,136
b. Kyeonggi Do	512,616	41,395.4	406,255.7	64,946
c. Chungcheon Nam Do	20,291	1,007.0	14,810.7	4,473
Sub Total	1,171,632	74,500.9	944,556.2	152,574.9
III. Double Crop				
a. Bosan	1,427,583	27,028.0	1,378,077.2	22,478
b. Jeolla Bug Do	833,905	32,842.0	780,475.0	20,588
c. Jeolla Nam Do	498,088	24,722.4	379,264.8	94,100
d. Gyeongsang Bug Do	776,291	80,408.0	678,303.0	17,580
e. Gyeongsang Nam Do	21,304	948.0	15,465.0	489.1
Sub Total	3,557,171	165,948.4	3,231,585.0	159,637.6
Total	6,686,103	321,203.1	5,940,266.6	424,633.3

1/ Convertible forest is defined as the upland area possessing slope less than 24 degrees.

Source: Survey Report on Classification of Mountain Utilization 1970, Office of Forestry.

one-half of this total area being located in the double cropping region (Table 3). Of the 200 thousand hectares which have been classified as suitable for upland crops production, about 45 thousand hectares are suitable for mulberry and orchard crops, namely, apples, peaches, pears, and grapes. The other 74 thousand hectares with thin soil depth (excluded from this study) are particularly usable for pasture, and 40 thousand hectares with steep slopes considered usable mainly for mulberry, and grass.

It may be noted here that most of the farms in South Korea are small. The average size varies from .5 to greater than 1 hectare. About one third has a size of less than .5 hectare. One third has a size of .5 to 1 hectare, and one third has a size of greater than 1 hectare. Nevertheless, most of these small scale farmers would be willing to cultivate more land in order to increase their income and living standards, providing the alternative should prove profitable.

If we look at the history of upland development as described by Park[8], in the early 1960s, agricultural land development of hillside, the so-called bench terracing program was thought to contribute mostly to food crop production. Furthermore, in the late 1960s hillside development to increase production of silk, fruits, and livestock production has become prominent.

According to the official statistics the total area of the new upland development in the first Five-Year Economic Development (1962-1965) was more than 135 thousand hectares. The year of the greatest new upland development was in 1965, in which a total of 37,336 hectares were reportedly added to agricultural production and has diminished each year ever since.

P.L. 480 food grain are the major source of public investment for new upland development. For example, the government programs for developing

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[8]Park, op cit.

Table 3. Adjusted Potential Land Use By Province and Region For Class I and Class II Land (in Ha).

Region/Province	Class I Land 1/	Class I Land 2/	Total
I. Upland			
a. Chungcheon Bug Do	104.1	1,568.5	6,786.1
b. Jeju Do	7,790.7	6,003.6	42,888.0
Sub Total	7,894.8	7,572.1	49,674.1
II. Single Crop			
a. Kyeonggi Do	846.3	5,931.6	20,233.5
b. Chungcheon Nam Do	1,186.4	6,013.7	26,095.2
Sub Total	2,032.7	11,945.3	46,328.7
III. Double Crop			
a. Jeolla Bug Do	1,340.4	7,144.0	15,582.4
b. Jeolla Nam Do	20,847.4	12,047.2	50,693.4
c. Gyeongsang Bug Do	6,135.6	1,390.4	17,034.6
d. Gyeongsang Nam Do	2,922.8	4,301.2	20,703.8
Sub Total	31,246.2	24,882.8	104,014.2
Total	41,173.7	44,400.2	200,017.0

1/ Class I land has a slope less than 5 degrees.
2/ Class II land has a slope ranging from 5 to 9 degrees.

Source: Vincent's Report, Table 5, p. 31.

11 thousand hectares of new upland development in 1967 estimated the total cost for development as 0.8 billion won. However, 36 percent of the total cost was 8,300 tons of wheat flour, and 60 percent was the farmers own contribution, namely, the partipating of family labor for land development activities. Including the farmers own labor, the developing cost of a hectare of new upland was 73,700 won, or 24 won per pyong (Table 4). Excluding the farmers own labor, the developing cost per pyong was 9 won. Furthermore, under the investment plan of the government to develop 200 thousand hectares of new upland in the 1967-1971 period(Table 5) the developing cost per pyong as 28 won, of which the value of donated food grain was 19 won.

This historical experience will unlikely repeat itself in matters of cost relationships. Not only have per unit cost of development activities changed but also, it is quite natural that the land most amenable for development was developed first, leaving the land more difficult to develop for a later period. Nonetheless, as well as seen in the next chapter, this previous experience provided the basis for forming certain necessary judgments in designing the linear programming model.

Table 4. Investment Cost to Develop 11,000 Hectares of New Uplands in 1967.

Source of Funds	Total Investment	Investment Cost per Ha.	Investment Cost per Pyong
	Million Won	Won	Won
PL 480 food grain[1]	290 (8,080 MT)	26,400 (0.8 MT)	9
Subsidy Fund by Provincial Gov't	14	1,300	0
Farmer Contribution[2]	505	46,000	15
Total	817	73,700	24

[1] 1 MT of wheat flour was valued at 36,000 won.

[2] Contribution of family labor for land development.

Source: Agricultural Land Bureau, Ministry of Agriculture and Forestry.

Table 5. Investment Cost to Develop 20,000 Hectares of New Uplands in the 1967-1971 Period

Source of Funds	Total Required Budget	Development Cost per Ha.	Development Cost per Pyong
	Million Won	Won	Won
P.L.480 food grain[1]	11,350 (315,000 MT)	56,750 (1,6 MT)	19
Subsidy Fund by Provincial gov't.	510	2,550	1
Farmer Contribution[2]	5,080	25,400	8
Total	16,940	84,700	28

[1] 1 MT of wheat flour was valued at 36,000 won.

[2] Contribution of family labor for land development.

Source: Agricultural Land Bureau; Ministry of Agriculture and Forestry.

CHAPTER III

The Analytical Model

A. Introduction

Linear programming as a research tool in agricultural economics is well established. Man in his attempts to fulfill his economic goals is perennially faced with maximizing or minimizing something within the boundaries of resource limitations. Thus, where the assumptions of linear programming are reconcilable with the real world problem under study, the method can provide useful insights on how resources should be utilized in the achievement of a given objective.

There are many ways in which a national land development program can be viewed. Some of these ways would not coincide with an income maximizing objective. For example, it is conceivable that a nation could convert mountain land to new uses which would not contribute appreciably to the gross national product. Or for certain political reasons, it is quite conceivable that certain cropping patterns on newly developed land could be emphasized even though alternative systems would yield a higher return. To examine the problem, solution for a wide range of national goals is beyond the scope of this study. It was assumed that a linear programming solution which would maximize returns to land for a given set of hopefully realistic assumptions could serve as a useful component in the set of varied information required by policy-makers as they evolve an operational program of land development. We will not be able to say that land development is the best or even a good thing to do when compared with other possible uses of Korean energy and capital. Rather the position is that, if the uplands are to be developed we seek the cropping pattern which should be

encouraged on the new lands and we attempt to measure the magnitude of the payoff from such a cropping system.

The following are requirements of a linear programming problem:

(1) There must be an objective to be sought. It may take the form of minimizing or maximizing something.

(2) There must be alternative activities which could be undertaken and it must be possible to combine the activities in a way to achieve the objective.

(3) Resources must be in limited supply.

(4) The variables in the problems must be interrelated. This interrelationship will make possible a convergence in the solution.

(5) We must be able to express the objective relationship and the input utilization relationships as mathematical equations or inequalities, and these must be line or equations or inequalities.

The model will be specified by describing how these conditions were met for this problem. The order of presentation will be to discuss the crop alternatives first, followed by a description of the limiting resources and concluding with a definition of and method of computing the objective function.

B. Crop Enterprise (Alternative)

In determining which crop enterprise would be considered in the linear programming tableaux, the following criteria were used: (1) a crop would be considered if at least five percent of the land area of a province was devoted to the particular crop in 1971, (2) no crop would be considered that could not show a positive discounted cash flow over a 20 year period

for the assumptions employed and (3) two crops could be considered in combination for production on the land provided the labor requirements did not overlap in excess of 100 hours in a time period measured as one-tenth of a year. Only those crops which met all three criteria were considered eligible.

On the basis of land use capability studies, it was decided to restrict class 1 land to the growing of grains, potatoes, pulses, and vegetables and class 2 land to the growing of fruits, vegetables and mulberries. Grain crops included barley, wheat, and millet. Pulses included only soybeans. Both sweet potatoes and white potatoes are grown in Korea. Although many vegetables are adapted to Korean conditions, only the predominant vegetables of Chinese cabbage, radish and red pepper were considered. Fruit crops included apples, peaches, pears and grapes.

Crop yields were assumed to be essentially equal in all four provinces of the double cropping region (Jeolla Bug Do, Jeolla Nam Do, Gyeong Sang Bug Do, and Gyeong Sang Nam Do) but different for the two provinces of the single crop region (Kyenggi Do and Chungcheon Nam Do) and different among the three provinces of the upland region (Gangweon Do, Chungcheong Bug Do and Jeju Island). However, Gangwun Do was disqualified for analysis because of the apparent lack of class 1 and class 2 land in this province. Since each crop with a different expected yield was considered a separate activity and since the model was designed to yield a national solution including province/regional* answers, all potential crop enterprises had to be considered simultaneously. Thus, with 9 potential crops (ignoring

*For simplicity, the word "region" will be used henceforth to mean both province and region having different cropping systems or the same cropping system with different yield potential.

mixed combination) on class 1 land and with 8 potential crops on class 2 land for the 5 regions, this gives the possibility of 90 alternatives before the three criteria above were applied.

Considering the third criteria pertaining to mixed crops first, it was concluded that the following combinations would be feasible on class 1 land: barley-Chinese cabbage, barley-radish, wheat-Chinese cabbage, wheat-radish, and wheat-white potatoes. If these were suitable for all regions, this would increase the number of possible alternatives to 110.

However, with the application of the first and second criterion, 18 alternatives were eliminated from the analysis. The enterprises which were deemed ineligible are as follows:

Crop	Province or Region Not Eligible
Soybeans	Jeju
White potatoes	Chungcheon Nam, Jeju
Sweet potatoes	Kyenggi, Chungcheon Nam, Jeju
Millet	Kyenggi, Chungcheon Nam
Wheat, White Potatoes	Chungcheon Nam, Jeju
Apples	Jeju
Peaches	Kyenggi, Jeju
Grapes	Chungcheon Bug
Pears	Kyenggi, Chungcheong Bug, Jeju
Mulberry	Jeju

Thus, there were 92 different activities for different crops and different regions with two classes of lands. The results of applying criteria above, resulted in the specification of crop enterprises by province or region summarized in Table 6.

Table 6. Enterprise Code and Area Designations

Region / Crop Enterprise	Single Cropping		Double Crop	Upland Cropping	
	Gyenggi Do 1-1	Chongcheng Nam 1-2		Chungcheng Bug 3-2	Jeju 3-3
Barley	X	X	X	X	X
Wheat	X	X	X	X	X
Soybeans	X	X	X	X	
White Potatoes	X		X	X	
Sweet Potatoes			X		X
Millet			X	X	X
Chinese Cabbage 1	X	X	X	X	X
Radish 1	X	X	X	X	X
Red Pepper 1	X	X	X	X	X
Barley-C.Cabbage	X	X	X	X	X
Barley-Radish	X	X	X	X	X
Wheat-C.Cabbage	X	X	X	X	X
Wheat-Radish	X	X	X	X	X
Wheat-W.Potatoes	X		X	X	
Chinese Cabbage 2	X	X	X	X	X
Radish 2	X	X	X	X	X
Red Pepper 2	X	X	X	X	X
Apples	X	X	X	X	
Peaches		X	X	X	
Grapes	X	X	X	X	
Pears		X	X		
Mulberry	X	X	X	X	

Note: Enterprise admissible to linear programming solution for row-columns designated "x".

C. Constraints

Four basic categories of constraints were identified for this analysis: (a) land, (b) government subsidy at the regional or provincial level to provide incentive for clearing and development, (c) national subsidy capital to encourage a sustained level of agricultural productivity, and (d) arbitrary area limits on individual crops to retain a reasonable historical price relationship among the several crops.

The amount of available land area by land class and province or region was summarized in Table 3. To reiterate, it was determined that for the upland, single crop and double crop region there were 7,894.8, 2,032.7, and 31,246.2 hectares of available class I land and 7,572.1, 11,945.3, and 24,882.8 hectares of class II land respectively.

To establish realistic capital constraints at both the regional and national level was a difficult matter. The source of funding and the capital level for land development in the future is not known with certainty. The land development costs and development priorities vary by region. Past experience may give only partial vision on this subject. The investment cost to develop 200,000 hectares in the period 1967 to 1971 was 16,940 million won or average per hectare of 84,700 won (Table 5). Of this total 67 percent was financed from P.L. 480 food grain sources, 3 percent from subsidy fund of the provincial government and remainder of 30 percent was contributed by farmers involved in land development program.

Dr. Park[9] reports an average of 135 days of labor required per hectare ranging from 113 for land without bench terracing to 180 days for land with bench terracing. If labor was valued at 500 won per hour

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[9]Park, Ibid. p. 71.

this would result in labor cost per hectare of 675,000 won assuming a 10 hour day. (The average adult hired wage rate for 1970 was 579 won). Therefore, labor must have been valued at a very low rate in the primary development period because this estimate of cost is nearly eight times the reported period experience.

It was assumed that the provincial government would provide a subsidy to farmers as an incentive to land development. We note that the provincial government subsidy fund average 2,550 won per hectare developed in the 1967-71 period. It was assumed here that the amount of the subsidy would be released to labor expended by the farmers. If we assume 1200 hours of labor required for developing class I land and assume that the provincial government subsidize at the rate of 50 won per hour, this amounts to an average subsidy per hectare of 6000 won. If we assume 1400 hours of labor required for developing class II land on which more bench terrace would be required and if the subsidy rate is 50 won per hour, this would mean the average of 7000 won per hectare on this land class. Multiplying these allowances per hectare by the area of respective land classes, the total provincial capital allowance (constraint) was determined. The resulting provincial allowance for this subsidy for Gyeonggi, Chuncheong Nam, Double Cropping region, Chuncheong Bug, and Jeju Island in thousand won were 46,600, 49,214, 36,214, 11,600, and 88,774 respectively.

Since the subsidy is related to the development labor required, and since land capability for crop use depends on land classes, there would be different subsidy for different crops. The computed subsidy based on labor requirements for land development to be used for the production of grain (class I), vegetables (class I), vegetables (class II), fruit (class II), mulberry (class II) and mix crops (class I) were in won per hectare 5907, 7071, 7471, 6220, 6846, 7071 respectively.

Turning now to national capital allowance, it was decided to introduce an aspect not employed in the previous land development experience, namely, assistance to farmers for bringing developed land to its full productive capacity and maintaining over time. There is some evidence that much of the previously developed land was abandoned after a relatively short period. Bench terraces were not maintained. Insufficient plant nutrients and composts were applied to achieve adequate yields. This may be explained by too little capital in the hands of farmers and by discouragement associated with obtaining crop yields less than expected. Therefore, it seemed appropriate that some capital allowance should be provided to deal with this problem and that the direction of the program should be at the national level. The bases of estimate made by the Republic of Korea government for requirements for a community development project announced in 1972, the monetary requirements for lime, compost, fertilizer, etc. distributed over 20 years were computed as shown in Tables 7 and 8. These requirements were discussed at 18 percent interest rate as shown in Tables 9, 10, and 11. Anticipating that the linear programming solution could allow vegetables and grain crops to exceed 34 percent of the land area, fruit crops to exceed 53 percent and mulberries to exceed 13 percent, it was concluded that the total capital needed to sustain this supplementary program would not exceed these weights multiplied by the total land area. However, rather than expect the national government to make available the total requirement, it was decided arbitrarily to limit the subsidy to 50.0 percent of the requirement. The resulting national capital allowance for this activity was approximately 2,310 million won.

In addition to the above constraints it was decided to specify upper limits of area of individual crops in order to maintain output and price

Table 7. Distribution of Farmer's Development Costs By Year for Grain and Vegetables (WON/HA.)

Year	Lime	Additional Compost	Additional Fertilizer	Total
1	6218	8000	4000	18,218
2	0	6000	3000	9,000
3	0	4000	2000	6,000
4	6218	2000	1000	9,218
5	0	0	0	0
6	0	0	0	0
7	6218	0	0	6,218
8	0	0	0	0
9	0	0	0	0
10	6218	0	0	6,218
11	0	0	0	0
12	0	0	0	0
13	6218	0	0	6,218
14	0	0	0	0
15	0	0	0	0
16	0	0	0	6,218
17	0	0	0	0
18	0	0	0	0
19	0	0	0	6,218
20	0	0	0	0

Source: MOAF, Republic of Korea

Table 8. Distribution of Farmer's Development Costs by Year For Fruit Crops and Mulberry (Won/Ha.)

Year	Lime	Additional Compost	Additional Fertilizer	Plants		Total	
				Fruits	Mulberry	Fruits	Mulberry
1	4,000	5,000	4,000	58,400	4,500	71,400	17,500
2	0	4,000	3,000	0	0	7,000	7,000
3	0	3,000	2,000	0	0	5,000	5,000
4	0	2,000	1,000	0	0	3,000	3,000
5	0	1,000	0	0	0	1,000	1,000
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	4,000	0	0	0	0	4,000	4,000
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	4,000	0	0	0	0	4,000	4,000
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	4,000	0	0	0	0	4,000	4,000

Source: MOAF, Republic of Korea

Table 9. - Total Discounted Capital Requirement to Meet Annual Supplementary Development Costs by Year for Grain 1/ and Vegetables 2/

(won/Ha.)

Year	Needed Requirement*/	Discount Factor**/	Discounted Requirement
1	18,218	1,000	18,218
2	9,000	.8474	7,626.6
3	6,000	.7181	6,408.6
4	9,218	.6086	5,640.1
5	0	0	0
6	0	0	0
7	6,218	.3704	2,303.1
8	0	0	0
9	0	0	0
10	6,218	.2254	1,401.5
11	0	0	0
12	0	0	0
13	6,218	.1372	853.0
14	0	0	0
15	0	0	0
16	6,218	.8351	519.2
17	0	0	0
18	0	0	0
19	6,218	.5083	315.9
20	0	0	0
			43,286***/

1/ Grain: consists of barley, wheat, soybeans, white potatoes, sweet potatoes, and millet.

2/ Vegetables: consist of Chinese cabbage, radishes and red peppers.

*/ Data based on Table 7.

**/ Using 18 percent discount value.

***/ Total discounted requirement has to be deducted by 50 percent for Government Subsidy.

Table 10. - Total Discounted Capital Requirement to Meet Annual Supplementary Development Costs by Year for Fruit Crops[1/]

(won/Ha.)

Year	Needed Requirement[*/]	Discount Factor[**/]	Discounted Requirement
1	71,400	1,000	71,400
2	7,000	.8474	5,932
3	5,000	.7181	3,591
4	3,000	.6086	1,826
5	1,000	.5157	515.7
6	0	0	0
7	0	0	0
8	4,000	.3139	1,255.6
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	4,000	.1162	464.8
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	4,000	.0430	172.0
	Total		85,157[***/]

[*/] Data based on Table 8.

[**/] Using 18 percent discount value.

[***/] Total discounted requirement has to be deducted by 50 percent for Government Subsidy.

[1/] Apples, peaches, grapes, and pears.

Table 11. - Total Discounted Capital Requirement to Meet Annual Supplementary Development Costs by Year for Mulberry

(won/Ha.)

Year	Needed Requirement*/	Discount Factor**/	Discounted Requirement
1	17,500	1.000	17,500
2	7,000	.8474	5,932
3	5,000	.7181	3,591
4	3,000	.6086	1,826
5	1,000	.5157	516.7
6	0	0	0
7	0	0	0
8	4,000	.3139	1,255.6
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	4,000	.1162	464.8
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	4,000	.0430	172.0
			31,258***/

*/ Data based on Table 8.

**/ Using 18 percent discount value.

***/ Total discounted requirement has to be deducted by 50 percent for Government Subsidy.

relationships comparable to that experienced in the recent years. It was learned through the survey efforts of Dr. Park that the following percentages represented the land use pattern for newly developed land in the 1967-71 period: barley 36, wheat 48, soybeans 85, white potatoes 44, sweet potatoes 68, millet 4, vegetables for both class I and II 13, fruit 11, and mulberry 15. Using these same percentages, individual crop maxima for the nation were computed. These area limits may be incompatible with the conclusions that would be reached with more complete land capability data and adequate demand analysis for agricultural commodities. However, for lack of such information, these limits were imposed. It is recognized that imposing the limits at the national yields a different answer than if imposed at the regional or provincial level. The choice was made to apply the crop maxima constraints at the national level in order to give direction as to the areas in which individual crops have relative advantage rather than to force less profitable crops into the solution for each region.

One might expect that with current peak labor requirements having caused some concern given the present land under cultivation additional developed land would seriously amplify the problem. However, the analysis of Vincent and Kim[10] concluded that labor supply presents no serious restriction on new land development in the immediate future.

D. Objective Function

The objective was to specify the optimum allocation of land and capital to alternative land use activities for each of three policy strategies proposed by the KASS research team. Those three alternative strategies

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[10]Warren H. Vincent and Kim, Byeong Do, op. cit.

were as follows: the policy strategy set under alternative I corresponds to the Third Five Year Plan 1971 to 1976. The major policy goals for agriculture include (1) increasing the agricultural products with emphasis on attaining full self-sufficiency in food grains, particularly rice by 1976, (2) increasing incomes for farmers with an emphasis upon narrowing the farm-nonfarm income gap, (3) establishing an expanded agricultural production base, (4) improving the quality of rural life with emphasis on infrastructure and public services development.

Alternative II, seeks increased effectiveness and efficiency in attainment of the goals of food self-sufficiency and rural income generation. Specifically, this policy set includes components similar to those found in the Third Five Year Plan, but different emphasis and levels of investment.

The policy strategy set under alternative III placed greater reliance on competitive market to allocate productive resources and ration goods to consumers. It also signals the direction and emphasis of agricultural research and extension, and provides the government with cues to the direction of policy formulation and program development that will encourage the necessary economic and social adjustments consistent with competitive market forces. An open economy free trade policy is assumed for agricultural products and inputs.

As far as this analysis is concerned, the alternative policy strategies have the effect of providing three sets of crop yields and crop prices to be used in the computation of the objective function as explained below. With regard to the type of linear programming model to employ it was decided to compress the analysis into single solution using the 20 years discounted net cash flow of individual productive activities as the objective function to be maximized rather than to apply a poly period linear programming

technique. The present value of the income stream was computed as follows:

$$PV_j = \sum_{i=1}^{21} \frac{Y_{ij} \times P_{ij} - V_{c_{ij}} + PS_{ij} + NS_{ij}}{(1+r)^{21}}$$

i : 1,2,3,.. ....21 where 1 is the year of development and 2,3,4,...
21 are years of crop production

j : j th enterprise 1, 2, 3, ... 92

PV: present value

Y : yield

P : price received by the farmers

VC: variable production cost

PS: provincial subsidy, (development cost as a subsidy paid to the farmer in year 1)

NS: national subsidy, (maintenance cost paid as periodic subsidy)

r : discount rate (18 percent)

The results in computing the present value of the cash flow stream for individual enterprises for 20 years of production following a subsidized year of development are summarized in Tables 12, 13, and 14. Details for computing these results are as follows:

Yield: The procedure for projecting crop yields from 1970 to 1990 was first to establish a base yield by region and then to project from this base using an annual trend. The annual trend was determined by KASS research team to vary by policy strategy. Base yields (1971) were computed for regions by adjusting from the national crop average by the same percentage as individual regions differed from the national average during the period of 1965-1969 (Table 15).

Table 12. Present Value of Twenty Year Net Cash Flow for Selected Enterprises by Region (Thousand Won/Ha.) 1/

Region / Enterprises	Korea	Single Cropping		Double Cropping	Upland Cropping	
		Kyeonggi	Chungcheong Nam		Chungchong Bug	Jeju
Barley	322.7	329.9	370.4	321.0	364.0	267.0
Wheat	222.1	445.6	425.0	411.3	409.1	235.6
Soybeans	189.2	170.1	197.1	179.0	202.7	0
White Potatoes	81.1	88.0	0	76.0	76.7	0
Sweet Potatoes	211.2	0	0	199.9	0	228.3
Millet	206.3	0	0	202.2	189.9	225.2
Chinese Cabbage 1	656.5	623.5	653.2	584.8	618.3	811.7
Radish 1	741.3	700.4	671.7	734.0	683.3	997.3
Red Pepper 1	2,292.7	3,331.1	2,879.3	2,947,4	3,157.3	3,903.1
Barley-C. Cabbage	979.2	953.5	1,023.6	905.8	982.3	1,078.7
Barley-Radish	1,064.0	1,030.3	1,142.1	1,055.1	1,047.2	1,264.3
Wheat-C. Cabbage	878.7	1,069.1	1,078.2	996.1	1,027.5	1,047.4
Wheat-Radish	963.5	1,146.0	1,096.7	1,145.4	1,092.4	1,233.0
Wheat-W. Potato	303.3	533.6	0	407.3	485.9	0
Chinese Cabbage 2	656.9	623.9	653.6	585.2	618.7	812.1
Radish 2	741.8	700.8	672.1	734.5	683.7	997.7
Red Pepper 2	2,923.1	3,331.5	2,879.7	2,947.8	3,157,8	3,903.5
Apples	135.9	95.9	131.7	183.7	132.2	0
Peaches	63.8	0	56.2	74.2	61.2	0
Grapes	283.2	304.0	241.9	240.4	0	346.3
Pears	260.9	0	229.7	292.1	0	0
Mulberry	336.7	362.0	297.7	355.8	350.1	0

1/ Using Alternative I

Table 13. Present Value of Twenty Year Net Cash Flow for Selected Enterprises by Region. (Thousand Won/Ha.) 2/

Region / Enterprise	Korea	Single Cropping		Double Cropping	Upland Cropping	
		Kyeonggi	Chungcheong Nam		Chungchong Bug	Jeju
Barley	353.5	361.0	483.5	351.8	396.7	295.1
Wheat	230.3	453.7	433.2	419.5	417.3	243.8
Soybeans	206.8	187.7	214.8	196.6	220.2	0
White Potatoes	81.9	88.7	0	71.9	77.5	0
Sweet Potatoes	2,134.0	0	0	202.6	0	230.9
Millet	247.3	0	0	242.9	229.5	267.9
Chinese Cabbage	700.8	665.8	697.2	624.6	660.2	865.6
Radish	973.9	750.4	719.9	785.1	732.2	1,065.8
Red Pepper	3,135.1	3,568.9	3,089.0	3,161.2	3,384.3	4,176.5
Barley-C.Cabbage	1,054.3	1,026.9	1,180.7	976.3	945.4	1,319.3
Barley-Radish	1,147.4	1,111.4	1,203.4	1,137.8	1,017.3	1,519.6
Wheat-C. Cabbage	931.1	1,091.0	1,116.7	1,041.9	904.0	1,072.4
Wheat-Radish	1,024.2	1,183.6	1,239.4	1,203.5	976.0	1,272.7
Wheat-W.Potatoes	312.3	522.0	0	489.1	321.3	0
Chinese Cabbage 2	701.2	666.1	697.7	625.0	660.6	866.0
Radish 2	794.3	750.8	720.3	786.6	732.6	1,066.2
Red Pepper 2	3,135.5	3,569.3	3,089.3	3,161.6	3,384.7	4,176.9
Apples	148.6	104.6	144.0	201.2	144.5	0
Peaches	65.2	0	57.3	76.0	62.6	0
Grapes	321.8	343.4	279.0	277.4	0	387.3
Pears	285.4	0	251.7	319.0	0	0
Mulberry	356.5	382.3	317.0	355.6	370.3	0

2/ Using Alternative II

Table 14. Present Value of Twenty Year Net Cash Flow for Selected Enterprises By Region.
(Thousand Won/Ha.) 3/

Region / Enterprises	Korea	Single Cropping		Double	Upland Cropping	
		Kyeonggi	Chungcheong Nam		Chungchong Bug	Jeju
Barley	252.3	258.0	290.2	251.0	285.1	208.0
Wheat	192.2	387.8	369.8	357.9	355.9	204.0
Soybeans	176.6	157.5	184.5	166.4	190.0	0
White Potatoes	85.7	93.3	0	80.1	80.9	0
Sweet Potatoes	226.2	0	0	213.7	0	245.1
Millet	134.4	0	0	131.6	122.8	147.9
Chinese Cabbage	655.4	622.7	652.1	584.2	617.5	809.3
Radish	742.0	701.3	672.9	734.8	684.4	996.0
Red Pepper	2,925.1	3,330.1	2,882.0	294.5	3,157.8	3,897.5
Barley-C.Cabbage	907.7	880.7	942.3	935.2	825.5	1,197.1
Barley-Radish	994.3	959.4	963.1	985,8	892.4	1,343.8
Wheat-C. Cabbage	847.6	992.5	1,009.9	1,040.1	921.5	985.9
Wheat-Radish	134.2	1,071.3	1,030.7	1,090.7	888.4	1,172.5
Wheat-W. Potatoes	278.0	463.2	0	446.0	284.8	0
Chinese Cabbage 2	655.8	623.1	652.4	584.6	618.0	809.7
Radish 2	742.4	701.7	673.3	735.2	684.8	996.4
Red Pepper 2	2,925.5	3,350.5	2,882.4	2,949.9	3,158.2	3,898.0
Apples	141.8	100.6	137.5	191.0	138.0	0
Peaches	64.1	0	56.6	74.3	61.7	0
Grapes	307.1	327.6	266.4	264.9	0	369.4
Pears	270.4	0	238.8	302.0	0	0
Mulberry	331.7	356.5	293.4	330.8	345.0	0

3/ Using Alternative III.

Table 15 - Yield Base, 1971, for Fourteen Crop Groups by Province and Region

(kg./ha.)

Crop	Trend for 1970-85 for Strategy 1/			Region	Single Crop		Double	Upland Crop	
	I	II	III	0.0	Gyeonggi Do	Chongchong Nam		Owychong Bog	Jeju
Barley	1.0	1.7	0.5	2190.0	2247.0	2567.0	2177.0	2516.0	1750.0
Wheat	1.0	1.7	0.5	2244.0	4879.0	4635.0	4472.0	4446.0	2384.0
Soybeans	1.0	1.7	0.5	744.0	643.0	786.0	690.0	815.0	0
White Potatoes	1.0	1.5	0.5	2241.0	2519.0	0	2035.0	2062.0	0
Sweet Potatoes	1.0	1.5	0.5	5102.0	0	0	4778.0	0	5586.0
Millet	1.0	1.5	0.5	868.0	0	0	8420.0	7630.0	9890.0
Chinese Cabbage	1.0	1.2	1.2	13026.0	12323.0	12955.0	11496.0	12212.0	16336.0
Radish	1.0	1.2	1.2	14103.0	13257.0	12664.0	13953.0	12904.0	19392.0
Red Pepper	1.0	1.2	1.2	1906.0	2188.0	1876.0	1923.0	2068.0	2583.0
Apple	1.0	1.2	1.2	7978.0	3957.0	7555.0	12789.0	7611.0	0
Peach	1.0	1.2	1.2	5161.0	0	3091.0	7953.0	4480.0	0
Grape	1.0	1.2	1.2	1120.0	1321.0	722.0	707.0	0	1730.0
Pear	1.0	1.2	1.2	8552.0	0	7132.0	9972.0	0	0
Mulberry	1.0	1.2	1.0	280.0	308.0	237.0	279.0	295.0	0

1/1985 to 1970 trend is equal half of 1970-85 trend.

Source: 1. Vincent's Report Table 9, 10, and 11 - p. 34-s
2. Kass Report Table IV-3 p. 126.

Base yields are regarded as the average yield on developed land. Time is required to achieve fertility levels on newly developed land equal to the base yields. The yield expectations on newly developed land as a proportion of basic yield is shown in Table 16.

Prices: The KASS report did not contain projections of prices received by farmers for the products used in this study. It did, however, present consumer price expectations for several commodities under study when projections were reported for 1975, 1980 and 1985 for each of the policy strategies. With the desire to keep this analysis compatible with the KASS research, attempts were made to adjust the reported prices to corresponding prices received by farmers. Estimates of the marketing margins for the several crops were obtained from the research reported by one of the KASS teams.[11] These margins were used to adjust predicted consumer prices back to the farm level. Reported 1971 farm prices, when available, were used for the base year. Farm prices for 1971 were unavailable, from immediate sources, for soybeans, white potatoes, sweet potatoes, and millet. For these crops, the 1971 base year was estimated using single least squares regression. In some cases, where the 1971 reported price departed substantially from recent years, the 1966-70 five year average was used.

The resulting prices received by farmers for the 14 commodities are shown in Tables 17, 18 and 19.

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[11] Han, S. K., Y. S. Hong, C. S. Park, J. D. Shaffer, W. J. Song, K. W. Suh and W. H. Suk, "Organization and Performance of the Agricultural Marketing System of Korea", Special Report No. 7, Agricultural Economics Research Institute, Ministry of Agriculture and Forestry, Seoul, Korea, 1972.

Table 16. - Assumed Yield Expectations on Newly Developed Land as a Proportion of 1965-1970 Performance on Developed Land by Year, Over 20 Years

Year	Crops						
	Grain[1/]	Apples[*/]	Peach[*/]	Grape[*/]	Pear[*/]	Mulberry[*/]	Vegetable[2/]
1	.4	0	0	0	0	0	.4
2	.6	0	0	0	0	0	.6
3	.8	0	0	0	0	.6	.8
4	1.0	0	.2	.2	0	.8	1.0
5	1.0	0	.4	.4	0	1.0	1.0
6	1.0	0	.6	.6	0	1.0	1.0
7	1.0	0	.7	.7	.2	1.0	1.0
8	1.0	0	.8	.8	.3	1.0	1.0
9	1.0	.2	.9	.9	.3	1.0	1.0
10	1.0	.3	1.0	1.0	.6	1.0	1.0
11	1.0	.3	1.0	1.0	.5	1.0	1.0
12	1.0	.4	1.0	1.0	.6	1.0	1.0
13	1.0	.5	1.0	1.0	.6	1.0	1.0
14	1.0	.6	1.0	1.0	.7	1.0	1.0
15	1.0	.6	1.0	1.0	.8	1.0	1.0
16	1.0	.7	1.0	1.0	.8	1.0	1.0
17	1.0	.8	1.0	1.0	.9	1.0	1.0
18	1.0	.8	1.0	1.0	.9	1.0	1.0
19	1.0	.9	1.0	1.0	.9	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Source: [*/]The analysis of profitability on fruit trees by age of tree.

[1/]Grain consists of: Barley, Wheat, Soybeans, White Potatoes, Sweet Potatoes, and Millet.

[2/]Vegetables consist of: Chinese Cabbage, Radishes and Red Peppers.

Table 17 Prices Received Base 1971 and Projection for 20 Years for Six Crop Groups Under Three Alternative Strategies (won/kg.)

Year	Alternative	Barley	Wheat	Soybeans	White Potatoes	Sweet Potatoes	Millet
1971	I	34.32	47.78	72.24	18.96	15.20	45.52
	II	34.32	27.78	72.24	18.96	15.20	45.52
	III	34.32	27.78	72.24	18.96	15.20	45.52
1972	I	36.96	29.63	72.24	18.22	14.61	46.91
	II	37.62	29.63	72.24	18.25	14.63	48.77
	III	34.13	28.28	72.24	18.96	15.20	43.06
1973	I	39.00	31.48	72.24	17.49	14.02	48.30
	II	40.92	31.48	72.24	17.53	14.06	52.02
	III	33.95	28.77	72.24	18.96	15.20	40.60
1974	I	42.24	33.34	72.24	16.75	13.43	49.68
	II	44.22	33.34	72.24	16.82	13.48	55.27
	III	33.76	29.27	72.24	18.96	15.20	38.14
1975	I	44.88	35.19	72.24	16.01	12.84	51.07
	II	47.52	35.19	72.24	16.11	12.91	58.53
	III	33.57	29.76	72.24	18.96	15.20	35.68
1976	I	44.88	35.19	72.24	16.16	12.96	53.51
	II	47.52	35.19	72.24	16.19	12.98	60.20
	III	33.57	29.76	72.24	18.96	15.20	35.68
1977	I	44.88	35.19	72.24	16.31	13.07	55.96
	II	47.52	35.19	72.24	16.27	13.04	61.86
	III	33.57	29.76	72.24	18.96	15.20	35.68
1978	I	44.88	35.19	72.24	16.46	13.19	58.40
	II	47.52	35.19	72.24	16.35	13.11	63.53
	III	33.57	29.76	72.24	18.96	15.20	35.68
1979	I	44.88	35.19	72.24	16.00	13.31	60.84
	II	47.52	35.19	72.24	16.43	13.17	65.21
	III	33.57	29.76	72.24	18.96	15.20	35.68
1980	I	44.88	35.19	72.24	16.75	13.43	63.28
	II	47.52	35.19	72.24	16.51	13.27	66.89
	III	33.57	29.76	72.24	18.96	15.20	36.68
1981	I	44.88	35.19	72.24	17.08	13.96	63.51
	II	47.52	35.19	72.24	16.76	13.43	67.44
	III	33.59	29.76	72.24	18.96	15.20	36.42
1982	I	44.88	35.19	72.24	17.41	13.96	63.73
	II	47.52	35.19	72.24	17.00	13.63	68.00
	III	33.57	29.76	72.24	18.96	15.20	37.15
1983	I	44.88	35.19	72.24	17.75	14.23	63.95
	II	47.52	35.19	72.24	17.25	13.83	68.56
	III	33.57	29.76	72.24	18.96	15.20	37.89
1984	I	44.88	35.19	72.24	18.08	14.49	64.17
	II	47.52	35.19	72.24	17.49	14.02	69.12
	III	33.57	29.76	72.24	18.96	15.20	38.63
1985	I	44.88	35.19	72.24	18.41	14.76	64.39
	II	47.52	35.19	72.24	17.74	14.22	69.67
	III	33.57	29.76	72.24	18.96	15.20	39.37
1986	I	44.88	35.19	72.24	18.41	14.76	64.39
	II	47.52	35.19	72.24	17.74	14.22	69.67
	III	33.57	29.76	72.24	18.96	15.20	39.37
1987	I	44.88	35.19	72.24	18.41	14.76	64.39
	II	47.52	35.19	72.24	17.74	14.22	69.67
	III	33.57	29.76	72.24	18.96	15.20	39.37
1988	I	44.88	35.19	72.24	18.41	14.76	64.39
	II	47.52	35.19	72.24	17.74	14.22	69.67
	III	33.57	29.76	72.24	18.96	15.20	39.37
1989	I	44.88	35.19	72.24	18.41	14.76	64.39
	II	47.52	35.19	72.24	17.74	14.22	69.67
	III	33.57	29.76	72.24	18.96	15.20	39.34
1990	I	44.88	35.19	72.24	17.74	14.76	64.39
	II	47.52	35.19	72.24	18.96	14.22	69.67
	III	33.57	29.76	72.24	14.76	15.20	39.37

Table /8 Prices Received Base 1971 and Projection for 20 Years for Vegetables Under Three Alternative Strategies (won/kg.)

Year	Alternative	Chinese Cabbage	Radish	Red Pepper
1971	I	18.80	14.93	363.58
	II	18.80	14.93	363.58
	III	18.80	14.93	363.58
1972	I	18.15	14.41	350.92
	II	18.45	14.65	356.76
	III	18.15	14.42	351.08
1973	I	17.49	13.89	338.27
	II	18.09	14.57	349.95
	III	17.51	13.90	338.58
1974	I	16.84	13.37	328.61
	II	17.74	14.09	343.13
	III	16.86	13.39	326.09
1975	I	16.18	12.08	312.95
	II	17.39	13.81	336.31
	III	16.21	12.88	313.59
1976	I	16.56	13.15	320.32
	II	17.95	14.26	347.22
	III	16.59	13.18	320.86
1977	I	19.94	13.46	327.68
	II	18.52	14.71	358.13
	III	16.97	13.47	328.13
1978	I	17.32	13.76	335.05
	II	19.08	15.15	369.03
	III	17.34	13.77	335.40
1979	I	17.71	14.06	342.41
	II	19.65	15.60	379.94
	III	17.72	14.07	342.67
1980	I	18.09	14.36	349.77
	II	20.21	16.05	390.85
	III	18.09	14.37	349.95
1981	I	18.74	15.04	366.34
	II	20.87	16.57	403.57
	III	18.71	14.86	307.76
1982	I	19.80	15.72	382.91
	II	21.53	17.09	416.30
	III	19.32	15.34	573.58
1983	I	20.66	16.40	399.48
	II	22.18	17.62	429.02
	III	19.93	15.83	385.39
1984	I	21.51	17.08	416.05
	II	22.84	18.14	441.75
	III	20.54	16.31	397.21
1985	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	309.03
1986	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	409.03
1987	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	409.03
1988	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	409.03
1989	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	409.03
1990	I	22.37	17.76	432.61
	II	23.50	18.66	454.47
	III	21.15	16.80	409.03

Table 19. Prices Received Base 1971 and Projections for 20 Years for Fruit and Mulberry Under Three Alternative Strategies (won/kg.)

Year	Alternative	Apple	Peach	Grape	Pear	Mulberry
1971	I	57.73	33.07	77.33	57.12	461.0
	II	57.73	33.07	77.33	57.12	461.0
	III	57.73	33.07	77.33	57.12	461.0
1972	I	57.22	32.78	76.65	56.62	461.0
	II	56.67	32.47	75.92	56.08	461.0
	III	56.75	32.51	76.07	56.15	461.0
1973	I	56.71	32.49	75.97	56.11	461.0
	II	55.62	31.86	74.50	55.03	461.0
	III	55.76	31.94	74.69	55.17	461.0
1974	I	56.20	32.19	75.28	55.61	461.0
	II	54.56	37.26	73.09	53.99	461.0
	III	54.78	31.38	73.38	54.20	461.0
1975	I	55.67	31.90	74.60	55.10	461.0
	II	53.51	30.65	71.67	52.94	461.0
	III	53.79	30.82	72.06	53.23	461.0
1976	I	56.37	32.29	75.51	55.78	461.0
	II	54.91	31.46	73.56	54.33	461.0
	III	54.19	31.04	72.58	53.61	461.0
1977	I	57.05	32.68	76.42	56.45	461.0
	II	56.32	32.26	75.44	55.73	461.0
	III	54.58	31.27	73.11	54.00	461.0
1978	I	57.73	33.07	77.33	57.12	461.0
	II	57.73	33.07	77.33	57.12	461.0
	III	54.97	31.49	73.64	54.09	461.0
1979	I	58.41	33.46	38.24	58.46	461.0
	II	59.14	33.88	79.22	58.51	461.0
	III	55.37	31.72	74.17	54.78	461.0
1980	I	59.09	33.85	79.15	58.46	461.0
	II	60.55	34.68	81.10	59.91	461.0
	III	55.76	31.94	74.69	55.17	461.0
1981	I	59.09	33.85	79.15	58.46	461.0
	II	61.59	35.49	82.99	61.30	461.0
	III	57.34	32.84	76.80	56.73	461.0
1982	I	59.09	33.85	79.15	58.46	461.0
	II	63.36	36.30	84.87	62.69	461.0
	III	58.91	33.75	78.91	58.29	461.0
1983	I	59.09	33.85	79.15	58.46	461.0
	II	64.77	37.10	86.76	64.09	461.0
	III	60.49	34.65	81.02	59.85	461.0
1984	I	59.09	33.85	79.15	58.46	461.0
	II	66.18	37.91	88.65	65.48	461.0
	III	62.06	35.55	83.13	61.40	461.0
1985	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	30.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.96	461.0
1986	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	38.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.96	461.0
1987	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	38.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.96	461.0
1988	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	38.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.96	461.0
1989	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	38.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.96	461.0
1990	I	59.09	33.85	79.15	58.46	461.0
	II	67.59	38.72	90.53	66.87	461.0
	III	63.63	36.45	85.24	62.69	461.0

Variable Costs: Variable production cost was a difficult and unfortunately imprecise process to estimate for each enterprise and each sub-region. However, it was decided to estimate the total variable costs as a historical relationship to the gross value for individual crops as shown in Table 20.

Provincial Subsidy: In the previous section was discussed the idea that provincial governments would provide incentives for land development. The amount of incentive per hectare would depend on kind of crop and land class which, in turn, varied in its labor requirement. Multiplying estimated labor requirement in hours per hectare by minimal rate of W50 yielded the subsidy amounts for individual crops as reported earlier. This subsidy provided the only income received by farmers in the first year of the calculation of income streams.

National Subsidy: The concept of national subsidies for achieving and maintaining potential soil productivity was likewise discussed in the previous section. The amount of capital required for crop classes by year was shown in Tables 7 and 8 and the assumed level of participation (50 percent) on a discounted basis was shown in Tables 9, 10 and 11. These subsidy amounts were incorporated in the farmers' net cash flow for computing the respective objective function values.

Discount Rate: The choice of the appropriate interest rate in any discounting problem is a difficult matter. Possible choices include the opportunity cost of capital for individual farmers (accurate estimates are unavailable), the interest rate which farmers may have to pay for capital (perhaps ranging from 20 to 40 percent depending on source) and the interest rate to be paid by the government for development capital from external sources (perhaps as low as 7 percent). For this study, judgment dictated the arbitrary rate of 18 percent.

Table 20 Total Variable Production Costs and Gross Value for Selected Crops, Korea, 1969. Won/Ha.

Crop	Gross Value	TVC[1/]	TVC/GV
Barley	74,661	24,430	.327
Wheat	57,615	24,990	.433
Soybeans	39,560	16,250	.410
White Potatoes	58,032	39,230	.676
Sweet Potatoes	61,696	26,100	.423
Millet	29,864	10,460	.350
Chinese Cabbage	144,178	59,740	.414
Radish	144,932	34,540	.238
Red Pepper	599,486	38,900	.064
Apple	455,700	325,000	.713
Peach	189,120	179,500	.949
Grape	421,939	164,730	.390
Pear	321,178	184,559	.574
Mulberry	87,362	37,300	.426

[1/] Excluding self-service labor, capital interest, and land service.

Source: MAF "The Production Service of Major Agricultural Commodities per unit . . ." 1969.

CHAPTER IV

Results and Interpretations

A linear programming solution was computed for eight provinces located within three cropping pattern regions. The single cropping region consists of two provinces, double cropping consists of four provinces, and upland cropping consists of three provinces but only two were included in this analysis. We recall that the effective constraints were available for Class I land, available Class II land, and available capital at the regional and national levels. Three different alternative strategies (KASS Report) were set up for this analysis.

We had estimated Class I land available in single cropping regions for Kyeonggi Do 3.6.3 hectares, and for Chungcheong Nam Do 1,186.4 hectares. For Class II land Kyeonggi Do had 5,931.6 hectares and Chungcheng Nam Do 6,013.7 hectares. The LP solution specified the following crops with hectares of land coming in to solution shown in parentheses. Kyeonggi Do province under alternative I has combination of barley and chinese cabbage (846.0) for Class I land, grape (2,737.0), and mulberry (3,195.0) for Class II land (Table 21). In looking at the results under alternative II for Class I land a combination of barley and Chinese cabbage was replaced by wheat and white potatoes (846.0). But for Class II land the results were the same, grape (2,737.0) and mulberry (3,195.0) Table 22). The results under alternative III was exactly the same with alternative II (Table 23).

For Chungcheong Nam province the LP result under alternative I showed that for Class I land barley was favored (236.7), and the combination of barley and Chinese cabbage (949.3). All Class II land would be used for

Chinese cabbage (1,186.0) and Class II land favored Chinese cabbage (5,464.8). Alternative III, for Class I land favors barley (1,186.0) and on II land, favor Chinese cabbage (986.6). Looking at the slack activity under alternative I, II, and II for Kyeonggi Do province there was no unutilized Class I land, some Class II land. In Chungcheng Nam province we found under alternative I there would be 512.0 hectares of unutilized Class II land. While in alternative II unutilized Class II land was 549.9 hectares, and under alternative III unutilized Class II land was 5,027 hectares. Class I land was fully used. We had set the estimated amount of available capital for Kyenggi province at 46,000,000 won while for Chongcheong Nam Do 49,214,000 won. We found in the slack activity that in Kyenggi Do province, there was excess capital in the amount of 1,720,824 won in each alternative.

The total discounted net cash flow value of the objective function was 2,879.6 million won for Gyenggi Do, and 4,655.2 million won for Chungcheng Nam province (Table 21). Comparable results for alternative II and III are summarized in Tables 22 and 23.

In the case of double cropping (consisting of four provinces) favored barley (4,110.4), wheat (1,250.0), sweet potatoes (12,137.6) and a combination of wheat and white potatoes (13,748.0) for Class I land under alternative I (Table 21). It has been noted that estimated land available for Class I land was 31,246.2 hectares and Class II land was 24,882.8 hectares.

The LP solution for Class II land proposed radish (2,294.4), apples, peaches, and pears each at the policy maximum level of (2,737.0). These Class II land results were all the same under alternative I, II, and III (Tables 21, 22, and 23). We noticed that there were no Class I land unutilized under alternative I, II, and III. However 14,377.6 hectares of Class II land were unutilized under alternative I, II and III.

Alternatives II and III give different answers for Class I land. Alternative II, proposed barley (5,060.4), wheat (1,250.0), sweet potatoes (783.6), millet (11,250.0), and a combination of wheat and white potatoes (12,902.0). Under alternative III for Class I land, the solution proposed sweet potatoes (12,033.6), barley and Chinese cabbage (5,060.4), wheat and Chinese cabbage (1,250.0), and wheat and white potatoes (12,902). These results were also slightly different from alternative I. There were slack activities for capital in the double cropping region as follows: 92.9 million won, 93.9 million won, and 86.5 million won, under alternative I, II and II respectively. The total discounted net cash flow for these double cropping provinces were 14,652.4 million won, 14,814.2 million won, and 15,817 million won under alternative I, II, and III respectively.

We turn now to the LP results for the upland cropping region (consisting of two provinces) Chongcheong Bug Do and Jeju Island. We had estimated that Class I land available for Chungcheng Bug Do was 104.1 hectares and for Jeju Island 7,790.7 hectares. Class II land 1,568.3 hectares and 6,003.6 for Chungcheng Bug Do and Jeju Island respectively. The LP results under alternative I, II, and III are as follows: for Chungcheong Bug Do under alternative I, barley (104.0) for Class I land, and mulberry (537.0) for Class II land. Under alternative II, soybeans replaced barley in the solution on Class I land (104.0), in Class II land Chinese cabbage (646.2) and mulberry (537.0) (Table 20). Alternative III gave results similar to alternative II, except that Chinese cabbage was the alternative III solution. Looking at the resource utilization there was no unutilized Class I land. But there was unutilized Class II land in the amount of 1,031 hectares, 384.8 hectares and 1,031 hectares under alternative I, II and III respectively.

Turning to the last province Jeju Island, the LP solution for Class I land favored red pepper (2,788.4), and mixed crops barley and radish (5,200.6). The results for Class II land was red pepper (4,508.6). There was no excess Class I land, but there were 1495.4 hectares Class II land unutilized and no excess regional capital. From the results we noticed with regard to crop specification that the LP results for Jeju Island under alternatives I, II and III were exactly the same. The total discounted net cash flow for this program were 34,807.2 million won, 38,079.5 million won, and 35,164.4 million won under alternatives I, II, and III respectively (Tables 21, 22, and 23).

Generally speaking, the LP solution under these three alternative strategies were about the same.

We noticed from the LP results that soybeans appeared, for example, in solution only in Chungcheong Bug Do on Class I land. We might recall that soybeans are adapted to four provinces. Since the problem was defined nation-wide rather than regionally, the solution appears to prescribe specialization. These results are useful because it indicates which crops should receive greatest emphasis. Non-optimal activities have an opportunity cost which would reduce the total value of the objective function if grown. This condition, however, does not prohibit such crops from being grown.

Comparing the LP solution for the three cropping systems (single, double, upland cropping) we find that the highest total discounted net cash flow was in upland cropping, followed by double cropping, and single cropping. These total discounted net cash flow in upland cropping was 35,033.2 won, 38,728.2 million won and 35,369.4 million won under alternative I, II and III respectively. In the double cropping the total discounted net cash flow was 14,652.4 million won, 14,841.2 million won, and 15,817.0 million won, under alternative I, II and III respectively. In the single cropping the results were 7,534.8 million won under alternative I, 6,825.6 million won under alternative II, and 2,415.6 million won under alternative III. Yielding

the highest total discounted net cash flow for the Republic of Korea was that employing the assumptions of alternative II. Alternative III gave a result slightly lower than alternative I (Tables 21, 22, 23). The reasons for these results are that alternative II would favor rapid development of scientific agriculture whereas, alternative III would emphasize trade expansion wise deferred agricultural development.

We recalled that we had defined 92 activities for the LP analysis. From the results it is indicated that only 20 activities appeared in the solution under alternative II, and III, but only 18 activities under alternative III, which have shown positive net cash flow in the 20 year period. We had also set the level of national capital available at 273 billion won. The LP solution showed that about 798.7 million won, 779.2 million won, and 943.0 million won capital available at the national level were unutilized under alternative I, II, III respectively.

In summary and in evaluating the results it should be remembered that the solution to this may depend upon the specific limitation imposed by the assumption of the model, should these assumptions be altered, the answers would likewise be changed.

The apparent conclusions are as follows:

(1) The cropping pattern most profitable to a region depends upon price relationships. In this particular model forced the resulting area relationships for individual to be similar to that experienced in the past. This is done to minimize radical change in price relationships.

(2) Use of these crop area constraints, of course, affect the extent of new land development. Class I land was fully developed under each strategy, while Class II land would fall short of the full development proposal by about 17,416 hectares under alternative I and

and about 16,807.0 hectares under alternative II and about 21,931 hectares under alternative III.

(3) The amount of capital required for land development varied with price and relationship and expected monies, as a result of differing crop combination specified.

(4) A sizable increase in the total value of agricultural production would occur with an expanded development program. Measured in terms of the discounted total net cash flow for the three alternative strategies, the results indicated 56,717.6 million won, 61,485.1 million won, and 56,602.0 million won, under alternative I, II, and III respectively.

The conclusions and the implications about the use of the programming: linear programming is an efficient method for analyzing optimum crop combination. However, it has some shortcomings including linearity and homogeneity of resources. By linearity we mean that input factors combine in fixed proportions at all levels of output. Also, output will vary in fixed proportions with any given inputs and thus, neither economies nor diseconomies of scale exist. In the "real world" this is not always the case, because of the existence of the increasing or decreasing return to scale.

Homogeneity of resource is another assumption. This means that each category of resource is homogeneous in the linear programming approach. Under an actual farm situation, resources such as land may not be homogeneous, neither among farms nor within farms.

In the model which was used in our study risk and uncertainty were not included. The amount of increase or decrease in income should be decided on the basis of past experience with such variables as: price fluctuations and price elasticy, input availability, available facilities, physical conditions

including infrastructure, and other related factors.

Further development of this model could include a market demand-curve. In this case quadratic programming could be used.

We have taken arbitrary 18 percent interest rate. The choice of interest rate for the design and evaluation of public projects is perhaps the most difficult economic problem and yet one of the most important ones faced in this field. The use of a low interest rate would yield an altogether different kind of program than a higher interest rate.

Finally, it should be remembered that the results of the study depend upon the limitations imposed by the assumptions made in this study.

Table 21 L.P. Solution (Alternative I)

Activity	Level of Solution	Value of Solution	Excess Resource[1]	Shadow Price[2]
Region 1-1-1	(Hectare)	(Million won)	0	279.1
Barley-Chinese Cabbage	846.0	891.2		
Region 1-1-2			0	11.7
Grapes	2737	831.9		
Mulberry	3195	1156.6		
Total 1-1		2879.6		
Region 1-2-1			0	240.8
Barley	236.7	87.7		
Barley-Chinese Cabbage	949.3	971.7		
Region 1-2-2			512.3	0
Chinese Cabbage	5501.7	3595.8		
Total 1-2		4655.2		
Region 2-0-1			0	199.8
Barley	4110.4	1319.6		
Wheat	1250.0	514.2		
Sweet Potatoes	12137.6	2425.4		
Wheat-White Potatoes	13748.0	6700.0		
Region 2-0-2			14377.6	0
Radish	2294.4	1685.1		
Apples	2737.0	502.8		
Peaches	2737.0	203.0		
Pears	2737.0	799.5		
Total 2-0		14652.4		
Region 3-2-1			0	242.7
Barley	104.0	37.9		
Region 3-2-2			1031.0	0
Mulberry	537.0	188.1		
Total 3-2		226.0		
Region 3-3-1			0	21.5
Red Pepper	2788.4	10883.3		
Barley-Radish	5002.6	6324.8		
Region 3-3-2			1495.4	0
Red Pepper	4588.6	17599.1		
Total 3-3		34807.2		

Total Korea (0-0)		56,717.6	
Crop Tax:			
Barley		0	121.2
Wheat		0	211.5
Soybeans		26559.0	0
White Potatoes		0	76.0
Sweet Potatoes		9109.4	0
Millet		11250.0	0
Chinese Cabbage		0	658.1
Radish		0	734.4
Red Pepper		0	3,494.4
Apples		0	183.7
Peaches		0	74.2
Grapes		0	292.2
Pears		0	292.2
Mulberry		0	350.2
Capital Region	1-1	1720824.0	0
	1-2	0	.06
	2-0	92870412.0	0
	3-2	7309370.0	0
	3-3	0	.05
Capital National	0-0	798722667.1	0

1/ Unit in HA for crops. Thousand won for capital.

2/ Unit in thousand won.

Region 1-1-1	Gyenggi Do	Class I land
1-1-2	"	Class II land
1-2-1	Chongcheng Nam	Class I land
1-2-2	"	Class II land
2-0-1	Double Crop	Class I land
2-0-2	"	Class II land
3-2-1	Chungcheng Bug	Class I land
	"	Class II land
3-3-1	Jeju Island	Class I land
3-3-2	"	Class II land

Table 22 L.P. Solution (Alternative II)

Activity	Level of Solution	Value of Solution	Excess Resource[1]	Shadow Price[2]
Region 1-1-1	(Hectare)	(Mil. won)	0	235.4
Wheat, White Potatoes	846.0	441.6		
Region 1-1-2				
Grapes	2737.0	939.9		
Mulberry	3195.0	1221.4		
Total 1-1		1602.9		
Region 1-2-1			0	335.9
Barley-Chinese Cabbage	1186.0	1400.3		
Region 1-2-2			549.2	0
Chinese Cabbage	5464.8	3812.4		
Total 1-2		5212.7		
Region 2-0-1			0	202.6
Barley	5060.4	1780.0		
Wheat	1250.0	521.6		
Sweet Potatoes	783.6	158.8		
Millet	11250.0	2732.9		
Wheat-White Potatoes	12902.0	6311.4		
Region 2-0-2			14377.6	0
Radish	2294.4	1704.7		
Apples	2737.0	550.7		
Peaches	2737.0	207.9		
Pears	2737.0	873.2		
Total 2-0		14841.2		
Region 3-2-1			0	220.2
Soybeans	104.0	22.9		
Region 3-2-2			384.8	0
Chinese Cabbage	646.2	426.9		
Mulberry	537.0	198.9		
Total 3-2		648.7		
Region 3-3-1			0	30.9
Red pepper	2,788.4	11,645.7		
Barley-Radish	5,002.6	7,601.9		
Region 3-3-2			1,495.4	0
Red pepper	4,508.6	18,831.9		
Total 3-3		38,079.5		
Total Korea (0-0)		61,485.1		

Table 22 (con't.)

Crop Max. Barley	0	149.1
Wheat	0	214.7
Soybeans	26.4	0
Potatoes	0	71.9
Sweet Potatoes	20.7	0
Millet	0	40.3
Chinese cabbage	0	666.6
Radish	0	786.6
Red pepper	0	3,592.6
Apples	0	201.2
Peaches	0	76.0
Grapes	0	331.5
Pears	0	319.0
Mulberry	0	370.3
Capital Region 1-1	1,720.8	0
1-2	0	.004
2-0	99,855.2	0
3-2	2,481.9	0
3-3	0	.08
Capital National 0-0	779,251.8	0

Region 1-1-1	Gyenggi Do	Class I land
1-1-2	"	Class II land
1-2-1	Chongcheng Nam	Class I land
1-2-2	"	Class II land
2-0-1	Double Crop	Class I land
2-0-2	"	Class II land
3-2-1	Chungcheng Bug	Class I land
	"	Class II land
3-3-1	Jeju Island	Class I land
3-3-2	"	Class II land

1/ Unit in HA for crops. Thousand won for capital.

2/ Unit in thousand won.

Table 23 L. P. Solution (Alternative III)

Activity	Level of Solution (Hectare)	Value of Solution (Million Won)	Excess Resource	Shadow Price
Region 1-1-1			0	230.8
Wheat-White Potatoes	846.0	381.8		
Region 1-1-2			0	115.5
Chinese Cabbage	2737	896.7		
Mulberry	3195	1139.1		
Total 1-1		1427.6		
Region 1-2-1			0	221.2
Barley	1186.0	344.3		
Region 1-2-2			5027.4	0
Chinese Cabbage	986.6	643.7		
Total 1-2				
Region 2-0-1			0	283.6
Sweet Potatoes	12033.6	2570.9		
Barley-Chinese Cabbage	5060.4	4732.5		
Wheat-Chinese Cabbage	1250.0	1300.2		
Wheat-White Potatoes	12902.0	5754.8		
Region 2-0-2			14377.6	0
Radish	2294.4	1686.8		
Apples	2737.0	522.8		
Peaches	2737.0	203.4		
Pears	2737.0	1045.6		
Total 2-0		15817.0		
Region 3-2-1			0	190.0
Soybeans	104	198.		
Region 3-2-2			1031.0	0
Mulberry	537	185.3		
Total 3-2		205.1		
Region 3-3-1			0	28.5
Red Pepper	2788.4	10867.9		
Barley-Radish	5002.6	6722.3		
Region 3-3-2			1495.4	0
Red Pepper	4508.6	17574.2		
Total 3-3		35164.4		

Total Korea (0-0)		56602.0	
Crop Max.	Barley	0	69.1
	Wheat	0	174.0
	Soybeans	26455	0
	White Potatoes	0	58.4
	Sweet Potatoes	9213.4	0
	Millett	11250.0	0
	Chinese Cabbage	0	652.5
	Radish	0	735.2
	Red Peppers	0	3,358.0
	Apples	0	191.0
	Peaches	0	780.3
	Grapes	0	316.0
	Pears	0	382.0
	Mulberry	0	345.0
Capital Region	1-1	1,720.8	0
	1-2	34,837.3	0
	2-0	86,509.9	0
	3-2	7,399.4	0
	3-3	0	.07
Capital National	0-0	945,011.9	0

Region	1-1-1	Gyenggi Do	Class I land
	1-1-2	"	Class II land
	1-2-1	Chongcheng Nam	Class I land
	1-2-2	"	Class II land
	2-0-1	Double Crop	Class I land
	2-0-2	"	Class II land
	3-2-1	Chungcheng Bug	Class I land
		"	Class II land
	3-3-1	Jeju Island	Class I land
	3-3-2	"	Class II land

1/ Unit in HA for crops. Thousand won for capital.

2/ Unit in thousand won.

BIBLIOGRAPHY

Heady, Earl O. Linear Programming Methods, The Iowa State University Press, Ames, Iowa, U.S.A., 1958.

Haley, W. J., et. al. An Analysis of New Land Development in Korea, Korean Agricultural Sector Study, Special Report No. 3, Agricultural Economics Research Institute, Ministry of Agriculture and Forestry, Seoul, Korea, 1972.

Park, J. H. An Economic Analysis of Land Development Activities in Korea, Department of Agricultural Economics, College of Agriculture, Seoul, National University, 1969.

Rossmiller, George E., et al, Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, Agricultural Economics Research Institute, Seoul, Korea. Michigan State University, East Lansing, Michigan, July 1, 1972.

Shaffer, James D., et al, Organization and Performance of the Agricultural Marketing System in Korea, Special Report No. 7, Agricultural Economics Research Institute, Ministry of Agriculture and Forestry, Seoul, Korea. Department of Agricultural Economics, Michigan State University, East Lansing, 1972.

U. S. Department of Agriculture/ Economic Research Service/ ERS Foreign-306, Changing Food Consumption Patterns in The Republic of Korea, Washington, D.C., December, 1970.

Wright, Karl T. Preliminary Historical Data on Crops In Korea, September 1971.

Vincent, Warren H. and Byeng Do Kim, Upland Development In Korea, Unpublished Working Paper 3, Korea, 1972.