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KOREAN AGRICULTURAL SECTOR STUDY

Special Report 4.

AN ANALYSIS OF SUPPLY RESPONSE ON MAJOR AGRICULTURAL COMMODITIES IN KOREA

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FOREWORD

This publication is one of a series of Korean Agricultural Sector Study Special Reports. Through the cooperation of the Republic of Korea, Michigan State University and USAID, an agricultural sector study, entitled Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985 was completed between September 1971 and July 1972. Concurrent with and contributing to the sector study the rudimentary components of a computerized simulation model were developed. This work continues with the objective of developing and institutionalizing a fully operational agriculture sector simulation model as a tool for use by Korean decision makers in policy formulation and program development.

The KASS special reports are the result of the work of a number of joint Korean and American task forces established to collect and analyze data and develop working papers on a variety of specific topics for background and input and follow up to the sector analysis efforts. The reports are joint publications of the Agricultural Economics Research Institute, Ministry of Agriculture and Forestry, Republic of Korea and the Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

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TABLE OF CONTENTS

LIST OF TABLES

AN ANALYSIS OF SUPPLY RESPONSE ON MAJOR AGRICULTURAL COMMODITIES IN KOREA

Chapter I

Introduction

In order to identify feasible alternative price policies and other programs designed as economic incentives or disincentives in the agricultural sector, measurement of how producers and consumers have responded to such programs in the past was undertaken. A number of studies have been made on the effect of consumer prices and incomes on consumption of agricultural products. Relatively few efforts have been directed toward supply analysis. And of the investigations into supply response, most have been directed at rice. Problems in measuring supply response, if indeed Korean farmers do respond to price and other economic incentives, may have accounted for the lack of definitive information on supply.

Past Studies

Rex Daly, in conclusion to an assignment in Korea in May-June 1967 and May-June 1968, mentioned that "Attempts to relate changes in acreages and output to prices and other factors were not successful. It may be possible to get more meaningful indications on the supply response in agriculture by analyzing data for provinces or major producing areas."[1/] A similar suggestion was made by George Tolley.[2/]

[1/] Rex F. Daly, An Agricultural Outlook Service for Korea—With Analytical Appendix, Rural Development Division, United States Mission to Korea, Dec., 1968.

[2/] George S. Tolley, Research Needs for Korean Grain Price Policies, unpublished mimeograph, July, 1971.

Mr. Yong-jin Kim wrote a masters thesis at the University of Maryland on the subject, "An Economic Analysis of the South Korean Food Grain Sector."[3/] Mr. Kim constructed twelve behavioral relations and six definitional identities encompassing both the supply and demand side of the food grain sector. On the supply equation for the area of rice, barley and wheat, he used area lagged one year, undeflated price lagged one year, and serial time as independent variables. The signs on the coefficients were as expected but significant at the five percent level only on lagged price and time in the barley equation. The lagged price in the wheat equation approached significance. The long run supply elasticities in all three crops were quite low with barley having the greatest elasticity of around .1 - .2.

Another study aggregated the cereal crops in a supply equation with per capita domestic supply as the dependent variable, and a deflated index of wholesale prices of grain lagged two years as one of three dependent variables.[4/] The other two independent variables were the quantity of fertilizer applied per tanbo and a weather index constructed by taking yield deviation from a trend. This latter variable was quite significant as would be expected from its formulation. The fertilizer input variable was nearly "significant" but the lagged price variable was not. The supply elasticity on total cereal production implied by the equation is about .1. However, this probably understates the supply elasticity since fertilizer application is likely affected by cereal prices also.

[3/] Yong-jin Kim, An Econometric Analysis of the South Korean Food Grain Sector, unpublished masters thesis, University of Maryland, 1969.

[4/] Sang Gee Kim, The Impact of PL 480 Shipments on Prices and Domestic Production of Food Grain in Korea, AERI, Ministry of Agriculture and Forestry, Korea.

In Joon Seol, in a distributed lag supply model on rice, estimated a long run elasticity on area of .289 and on yield at 1.196.5/ This added up to a total long run supply elasticity of 1.485. This is substantially higher than a .3 long run elasticity on rice assumed by George Tolley in his study of Korean rice price policies.6/ Mr. Seol did obtain significant coefficients in deflated rice prices lagged one year, both in the acreage and in yield equations. The $\bar{R}^2$'s were .568 and .819 respectively for the two equations estimated from annual data for 1960-69.

Another study in rice using 1957-69 data produced a long run elasticity of supply of about .3.7/ In this study, the deflated price of rice lagged one year and "time" were significant in explaining rice production. A weather variable (rainfall in May and June in seven provinces) carried a positive coefficient and a "t" value of about 1.5. The $\bar{R}^2$ was .77. Lagging the dependent variable did not seem to have much effect.

Seong Woo Lee analyzed the supply elasticities on rice with respect to acreage and yield from data for 1960-67.8/ On area in rice, farmers did not respond significantly to changing rice prices relative to fertilizer prices. On yields, however, there was a significant relationship, with an elasticity of .18.

Little supply analysis has been reported on livestock. One study related a general livestock-feed price ratio in one year to farms with

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5/In Joon Seol, Analysis of Supply and Demand Structure for Rice in Korea, unpublished masters thesis, New Mexico State University, 1971.

6/Tolley observed that a supply elasticity of .3 had been estimated in previous studies for Korea and estimates from other countries typically ranged from .1 - .5. See G. S. Tolley, Rice Price Policy in Korea.

7/National Agricultural Cooperative Federation, Monthly Review, 3-1971. NACF, Seoul, Korea, pp. 3-11.

8/Seong Woo Lee, Supply and Demand Projection for Rice in Korea (1970-1980). Unpublished research paper, Department of Agricultural Economics, Michigan State University, 1970.

chickens and hog numbers in the next year.[9] Based on data for 1960-70 a correlation coefficient of .93 was established between the livestock-feed price ratio and the number of farm raising chickens and a correlation coefficient of .45 was estimated between the livestock-feed price ratio and hog numbers.

9/ Institute of Agricultural Economics, Feed Supply and Use for Livestock Production in Korea, Office of Rural Development, Ministry of Science and Technology, USAID, July, 1968.

Chapter II

The Model

Because of the lack of published research on supply and because of certain differences in the conclusions of past studies, an analysis of supply response was conducted on major Korean agricultural products. Using annual time series data which began in 1955 for most commodities, linear regression models were estimated for rice, barley, wheat, other cereals, pulses, potatoes, vegetables, fruit, mulberry, tobacco, beef, pork, cocoon, poultrymeat and eggs. Data were generally available on crops with respect to prices received by farmers, areas, yields, and production but only on rice was the information on production costs over long enough period of time to incorporate in the time series analysis. Statistics on livestock were more difficult to assemble so the analysis was somewhat abbreviated.

The first step in the analysis was to obtain as complete a description of Korean agriculture as possible and identify factors likely to influence farmers' production decisions. The statistics were then collected and processed into a form that would allow testing certain hypotheses about farmers' response to price and other economic incentives. The basic premises were that:

1. past prices strongly influence farmers' price expectations
2. farmers would begin to respond in a significant way a year after the price had changed
3. farmers would respond to increases in net income in about the same way whether due to higher prices, increased yields, increased direct subsidies or other reasons.
4. gross or net returns per hectare or per animal would be more significant in changing farmers production plans than would price alone.

5. farmers responses would be influenced by the general price level.

Traditionally, price is treated as an independent variable in supply analysis. The price of a major input and/or an index of input prices often are incorporated in some form. Prices of a few close substitutes in production may also be appropriate to include. With only 10-15 years of data, some limitations are imposed on how many separate variables can be included. Problems of intercorrelation among the variables over time also develop when several independent variables are used.

These difficulties can be reduced and more a priori information applied by using or constructing gross margins on various commodities. The impact of the components of gross returns (prices received, yields, direct subsidies) and direct costs (fertilizer, pesticides, hired labor, etc.) are measured in proportion to their contribution to the gross margin. This can all be incorporated in our variable and thus save on degrees of freedom. The tradeoff here is that the separate effect of the components are not measured separately. If a change in actual price affects expectations in a way different from a change in actual yields, then some bias is introduced in the results. This drawback, however, is felt to be minor in comparison with the advantages. Both price and gross returns (gross margin on rice) were tried, alternatively, in the equations and in most cases better results were obtained using gross returns.

Code

Following is the code on the variables used in the analysis. The basic data are included in Appendix A.

AX_t = Area of crop X in year t (1000 ha)

YX_t = Yield of crop X in year t (MT/ha)

QX_t = Production of product X in year t (1000 MT)

RX_t = Gross returns per hectare of crop X in year t* (W or 1000 W)

MX_t = Gross margin (Gross Returns minus Variable Costs) on product X in year t* (W or 1000 W)

PX_t = Farm price of product X in year t* (W/kg)

W_t = Rainfall in 7 provinces in May and June (simple average), m.m.

GX = Direct government payments (Mil W)*

$IPPF_t$ = Index of prices paid by farmers (1965 = 100)

ICP_t = Index of feed prices in year t (1965 = 100)

PWB_t = Wheat bran prices (W/kg)

PLC_t = Layer feed prices (W/kg)*

PBC_t = Broiler feed prices (W/kg)*

$NPPK_t$ = Net prices on hogs, i.e. hog price minus concentrate feed costs, (W/kg)*

$NPEG_t$ = Net prices on eggs, i.e. egg prices minus concentrate feed costs, (W/kg)*

$NPBR_t$ = Net prices on broilers, i.e. broiler prices minus concentrate feed costs, (W/kg)*

T = Serial time, 1956 = 1

*Deflated by the Index of Prices Paid by Farmers, 1965 = 100

The commodities (X) are as follows:

RC = Rice

BL = Barley

WH = Wheat

BW = Barley, Wheat, and Rye

OC = Other Cereals

PL = Pulses

PT = Potatoes

VG = Vegetables

FR = Fruit

CN = Cocoon

TB = Tobacco

BF = Beef

PK = Pork

PM = Poultrymeat

EG = Eggs

Regression Analysis

A standard linear regression analysis was conducted to estimate the supply equations for the various commodities. The "t" values on the coefficients are given in the parentheses. The $\bar{R}^2$ values and the standard errors on the estimates (SE) are also presented. Various combinations of variables listed in the code were explored and most reasonable equations were selected for presentation.

Rice

(1) $ARC_t = 435 + \underset{(3.39)}{.588}\, ARC_{t-1} + \underset{(2.06)}{.000661}\, MRC_{t-1} + \underset{(.44)}{.0482}\, W_t$

$\bar{R}^2 = .69$ SE. = 29

(2) $YRC_t = 2.31 + \underset{(2.18)}{.0363}\, T + \underset{(.69)}{.000002}\, MRC_{t-1} + \underset{(2.12)}{.00173}\, W_t$

$\bar{R}^2 = .50$ SE. = .22

(3) $QRC_t = 2441 + \underset{(2.99)}{63.7}\, T + \underset{(1.12)}{.00368}\, MRC_{t-1} + \underset{(1.84)}{1.91}\, W_t$

$\bar{R}^2 = .64$ SE. = 279

The gross margin variable in Equations (1), (2) and (3) requires some explanation. This was derived from estimates of average prices for November to April, yields per hectare and direct "out-of-the-pocket" costs per hectare. The average price for each month in November to April was weighted by the marketings "in the narrow sense". Marketings in the narrow sense and in the broad sense are estimated by NACF. Marketings in the narrow sense refer to commercial sales while those in the broad sense refer to both commercial sales and various types of payment in kind. The "narrow sense" were used in this analysis because data were available for a longer period of time. From this process of weighting prices by marketings, a realistic measurement was obtained of what farmers actually received for their rice in the period of time that would be influential in their production plans for the coming year. No season average prices are available on grain from official sources.

The prices on rice, so derived, were multiplied times yield to obtain a "gross returns" figure. Obviously farmers did not receive such amounts since half the rice crop is consumed at home. Even so, it provides a good indicator of the income possibilities from land in rice. Production costs, not including "self service," were deducted from the gross returns per hectare to give a gross margin figure. The "self service" items not included in the production costs were mostly imputed interest on land and capital and the value of the operator's labor.

The gross margin deflated by the Index of Prices Paid by Farmers was lagged one year in equations with acreage, yield and production of rice as dependent variables. In the acreage equation, acreage was also lagged one year to help measure the distributed lag effect postulated as a reasonable way in which farmers form expectations and adjust to these expectations. This approach or similar techniques have been suggested by Alt, Nerlove and others.

Also introduced into the acreage equation, and in the yield and production equation as well, was a weather variable. Rainfall in May and June is critical in determining just how much land can be planted to rice. This is particularly true in the rain fields and in the partially irrigated paddy land. This variable has been used in other studies including the one by Rex Daly.[10/]

The explanatory power of Equation (1) was not particularly high with an $\bar{R}^2$ of .69. The coefficients on lagged acreage and gross margin, however, were "significant" at the 5 percent level. The coefficient on the weather variable carried the "correct" sign but was not significant.

Rainfall in May and June influences the date of planting which in turn affects yields. On the yield equation, the weather variable was significant along with the time trend. The gross margin in the previous year, however, was not very important, according to Equation (2).

An alternative to measuring the impact of explanatory variables on acreage and on yield is to measure their effect directly on production. The results are presented in Equation (3). The coefficients on gross margin and rainfall were not significant but appeared "reasonable". By putting the equation in logarithmic form, the weather variable becomes significant.

Of particular interest is what these equations imply about the long run price elasticity of supply. Estimates were obtained by the following procedure.

[10/] Rex F. Daly, An Agricultural Outlook Service for Korea.

(a) For equations with a lagged dependent variable as an independent variable of the form,

$$X_t = a + b_1 X_{t-1} + b_2 P + b_3 Y$$

The equilibrium value of X can be calculated since

$X_t = X_{t-1}$ at equilibrium. That solution is

$$X_E = \frac{1}{1-b_1} (a + b_2 P + b_3 Y)$$

In the computations on rice and the other commodities, the P variables (lagged price, gross margin, gross returns) and the Y variables (returns to other crops, etc.) were set at the average of the most recent 3 years of data. One exception was the weather variable which was averaged over the entire 1956-70 period.

The next step was to raise the P variable by 10 percent and calculate the new equilibrium.

$$X'_E = \frac{1}{1-b_1} [a + b_2 (1.1) P + b_3 Y]$$

Then by comparing the new equilibrium with the original one, some estimate of the long run elasticity of supply could be obtained.

$[(X'_E \div X_E) - 1] \times 10$ = long run elasticity of supply

Also Y variables (additional independent variables) could be increased by 10 percent to estimate their respective long run cross elasticity effects.

(b) For equations with serial time (T) as an independent variable

$$X_t = a + b_1 T + b_2 P + b_3 Y$$

Projections were made to 1985 by setting T = 30, and Y variables were set at their actual values for the last 3 years, except for W, as was done for the equation described in (a). The P and Y variables were then increased by 10 percent (alternatively) and the resulting projection was compared with the original projection. In (a) it is assumed that the projections to 1985 would be very close to the equilibrium, so that the results for both (a) and (b) equations would be comparable.

Using the assumption that deflated gross margins will be the same in the future as in 1967-69 and that May-June rainfall will be average, the number of hectares in rice would remain relatively stable at about 1,203,000 hectares. If gross margins were raised by 10 percent, the area in rice would increase to 1,216,000 hectares, only about a 1 percent increase. This figures out to be a long run supply elasticity of .11 for gross margins as they affect area. Since gross returns on rice are about 1.4 times gross margins, the price effect is more like a .16 long run elasticity.

By 1985, rice yields would increase to about 3.75 MT/ha if the stated conditions for 1967-69 hold. At a 10 percent higher level of gross margins yields would be above, but not substantially higher than in the original situation. A long run supply elasticity of .044 was calculated on yields relative to gross margins and .062 relative to price.

Using Equation (3) on production, the 1985 projection is 4,868,000 MT, about 20 percent above recent levels. Raising gross margins by 10 percent would result in a production of 4,898,000 MT by 1980, .6 percent above the original projection. In other words, this equation estimates the long run elasticity of gross margin on production of .06 or about .085 with respect to price. Combining Equations (1) and (2) to estimate production response we calculate output at 4,517,000 MT at recent margins and 4,586,000 MT at the 10 percent higher margins. These equations generate a lower level of projection but a somewhat higher price elasticity of .212.

Another equation with production as the dependent variable resulted in a better "fit" to the data.

$$(4)\quad \text{Log } QRC_t = 6.867 + \underset{(4.48)}{.0217\ T} + \underset{(1.51)}{.178 \text{ Log } PRC_{t-1}} + \underset{(2.38)}{.0975 \text{ Log } W_t}$$

$$\bar{R}^2 = .70 \qquad\qquad SE. = .078$$

In this equation the elasticity of supply with respect to price can be obtained directly from the coefficient, i.e., .178. The conclusion, then, is that the elasticity of supply on rice, based on time series data for 1955-70, is between .085 and .212. This is somewhat less than obtained in other studies. Somewhat surprising is that price elasticities on yield appears to be less than on acreage. The opposite was expected to be the case. The overall low elasticity on total production, nevertheless, is about in line with what was anticipated.

It should be pointed out that there may well be a different elasticity for an expansion in area than for a contraction; very likely the elasticity for expansion is smaller than for a contraction. Therefore, the estimated elasticities would be on the high side in applying them to the impact of a higher price level on rice.

The results of this analysis on rice generally confirm the judgement of a number of persons we have questioned about the prospects for expanding rice area and yields. Some close to Korean agriculture are even concerned about saving existing paddy land from urban and industry expansion. They feel fertilizer application is near optimum but that improving the soil structure, liming and other cultural practices could raise yields by 15-20 percent. This would be in line with our projections to 1985.

While Equation (4) confirms the results of other equations with respect to long run price elasticity, it does show a strong time trend in production.

As the result, the 1985 projection of rice production is 5,330,000 MT, well above the 4,000,000 MT level of 1969 and 1970. This projection assumes the average deflated price for 1967-69. By raising the farm price to the announced government buying price for 1971 (8,750 W per 80 kg of polished rice or a deflated price of 47.5 W/kg) the projected production to 1985 would be 5,490,000 MT, only 3 percent higher than in the original projection. If Equation (4) has accurately measured the trend effect on rice production, the government should be able to attain their target of 4,627,000 MT by 1976. The other equations (1, 2 and 3), however, would question whether this target would be achieved before 1980. All the equations, in any case, would question whether substantial increases in rice prices would materially accelerate trends underway.

A regional analysis of supply response on rice was undertaken. This analysis is reported in Appendix C. The nation was divided into three regions, double paddy, single paddy and upland. Separate supply equations were estimated for each region. The results are not strictly comparable with the equations for the nation as a whole since urban areas were excluded from the regional analysis. Even with some allowance for this difference, the regional approach appeared to be an improvement over the national model. For 1961-70, the percent error in "national" estimates from the regional model was 3.37 compared with 4.94 in the national model.

Barley

(5) $$ABL_t = 152 + \underset{(6.75)}{.6478}\, ABL_{t-1} + \underset{(3.79)}{.004307}\, RBL_{t-1}$$

$$\bar{R}^2 = .90 \qquad SE = 27.8$$

(6) $$YBL_t = .455 + \underset{(3.06)}{.6829}\, YBL_{t-1} + \underset{(.33)}{.000003}\, RBL_{t-1}$$

$$\bar{R}^2 = .35 \qquad SE = .29$$

$$(7) \quad QBL_t = 23.56 + .7872\, QBL_{t-1} + .00916\, RBL_{t-1}$$
$$\qquad\qquad (4.91) \qquad\qquad (1.06)$$
$$\bar{R}^2 = .66 \qquad\qquad SE = 243$$

Gross returns per hectare from barley was a significant element in explaining acreage response. For yield, and consequently total production, this variable was apparently not an important factor. The gross returns variable was calculated from the yield per hectare and a simple average of the prices received by farmers for barley in June to September. This is the period when much of the crop which is marketed is sold. Also it is a period which is early enough to influence decisions on planting winter barley. Data on production costs per hectare are available back to 1963, but this was not a sufficient time period to incorporate these costs in a time series analysis.

By setting gross returns per hectare at the levels for 1967-69, the equilibrium area was calculated at 932,000 hectares, about the same as in 1970. By raising gross margins 10 percent, the equilibrium was increased to 982,000 hectares. This implies a .534 price elasticity of supply in area terms. The price elasticity of supply with respect to yield was only .212.

The equation in which yield was a function of time gave better results than Equation (6).

$$(8) \quad YBL_t = 1.24 + .06001\, T$$
$$\qquad (4.07)$$
$$\bar{R}^2 = .53 \qquad SE = .25$$

Using Equation (8) to project yields to 1985, about 3 MT per hectare would be produced. In combination with area projections, production would reach 2,833,000 MT under recent price levels or about 2,985,000 MT at 10 percent higher prices. This would be just a little shy of the pace for 1971-76 set for the Third-Year Plan.

If barley is to be used to help fill the food grain deficit gap and also provide energy for an expanding livestock industry, it would appear that price policy alone would not be sufficient to achieve this. Even so, it should be noted that farmers do respond in their plantings to price and are much more flexible than in rice. Profit incentives combined with efforts to develop varieties suitable for single paddy land may hold some promise in the longer run.

Wheat

(9) $AWH_t = 24.5 + .6854\ AWH_{t-1} + .000224\ RWH_{t-1}$
$\qquad\qquad (4.91) \qquad\qquad (2.75)$

$\bar{R}^2 = .76 \qquad\qquad SE = 6.65$

(10) $YWH_t = 1.72 + .03539\ T$
$\qquad\qquad (3.15)$

$\bar{R}^2 = .39 \qquad\qquad SE = .19$

(11) $QWH_t = 26.8 + .8526\ QWH_{t-1} + 1.319\ PWH_{t-1}$
$\qquad\qquad (5.44) \qquad\qquad (.77)$

$\bar{R}^2 = .66 \qquad\qquad SE = 29.0$

As with barley, gross returns per hectare on wheat influenced area significantly although little impact was noticed in yields. As a result, the effect on production was not statistically significant. Under the real price levels of 1967-69 (average for June-September), wheat area and production would tend to decline from 1970 levels. Even a 10 percent increase in prices and gross returns would not prevent some deadline. This of course, does not assume any major breakthroughs in technology on wheat production.

The long run elasticity of supply on wheat was estimated at about .25 for acreage and .46 for production responses. An effort was made to determine whether returns from barley relative to wheat would be a more appropriate variable to explain wheat acreage. There has been very little trend in this relationship although recent years have favored barley. This result was as follows:

(12) $$AWH_t = 45.2 + \underset{(5.05)}{.8249\, AWH_{t-1}} - \underset{(-.82)}{16.66\, (RBL \div RWH)_{t-1}}$$

$$\bar{R}^2 = .63 \qquad SE = 8.25$$

In solving this equation for equilibrium, a 1.1 cross elasticity of supply is implied. That is, a 10 percent increase in barley prices would be expected to reduce wheat acreage by 11 percent over time. Because of this close interrelationship between wheat and barley, it seemed appropriate to look at both crops (plus rye, a minor crop) together.

Barley, Wheat and Rye

(13) $$ABW_t = 220 + \underset{(6.50)}{.6166\, ABW_{t-1}} + \underset{(4.13)}{.00505\, RBW_{t-1}}$$

$$\bar{R}^2 = .90 \qquad SE = 29.2$$

(14) $$YBW_t = .493 + \underset{(3.06)}{.6708\, YBW_{t-1}} + \underset{(.32)}{.000003\, RBW_{t-1}}$$

$$\bar{R}^2 = .35 \qquad SE = .266$$

(15) $$QBW_t = 58 + \underset{(4.95)}{.7835\, QBW_{t-1}} + \underset{(1.11)}{.0106\, RBW_{t-1}}$$

$$\bar{R}^2 = .67 \qquad SE = 263$$

Holding real gross returns constant at recent levels would result in a stable area near the 1,084,000 hectares of 1970. A 10 percent increase in gross returns would raise acreage about 5 percent at equilibrium. On production, a projection of 2,?00,000 MT at equilibrium was calculated if gross returns remain stable while a 10 percent increase in gross returns would elevate production to 2,400,000 MT. These figures imply a .5 long run elasticity on area and a .9 elasticity on production.

The implications of these elasticity figures is that changing prices and returns on barley and wheat will result not only in some shifts between these cereals but also these cereals taken together interact with other crops.

Other Cereals (Mostly Corn and Millet)

$$(16)\quad QOC_t = 57.2 + \underset{(.66)}{.2162\, QOC_{t-1}} + \underset{(1.56)}{.002593\, ROC_{t-1}}$$

$$\bar{R}^2 = .41 \qquad SE = 16.8$$

This equation is based on only 11 years data from 1960 to 1970. An extension of recent gross returns per hectare would result in little change in production from the 124,000 MT level of 1970. A 10 percent increase in gross returns would push production up to 131,000 MT. The long run elasticity would then be about .420.

Pulses

$$(17)\quad APL_t = 175 + \underset{(1.70)}{.3515\, APL_{t-1}} + \underset{(2.84)}{.6331\, RPL^*_{t-1}}$$

$$\bar{R}^2 = .78 \qquad SE = 12.0$$

$$(18)\quad YPL_t = .0608 + \underset{(3.99)}{.7285\, YPL_{t-1}} + \underset{(2.43)}{.00139\, RPL^*_{t-1}}$$

$$\bar{R}^2 = .76 \qquad SE = .043$$

$$(19)\quad QPL_t = 10.5 + \underset{(4.4)}{.697\, QPL_{t-1}} + \underset{(2.6)}{.720\, RPL^*_{t-1}}$$

$$\bar{R}^2 = .84 \qquad SE = 17.8$$

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*Index of deflated gross returns per hectare, 1965 = 100

Area, yield and production on pulses (mostly soybeans) appeared to respond significantly to gross returns per hectare. Long run elasticities were estimated at .27 for area, .50 for yield and .88 for production. The recent level of real returns (1967-69) would maintain acreage and increase yields and production . Ten percent higher gross returns would boost production to 306,000 MT.

Potatoes

(20) $APT_t = 2.78 + .7626\ APT_{t-1} + .5211\ RPT_{t-1}$
$\qquad\qquad\qquad (13.93) \qquad\quad (5.17)$

$\bar{R}^2 = .99 \qquad SE = 9.25$

(21) $YPT_t = .19 + .8618\ YPT_{t-1} + .004872\ RPT_{t-1}$
$\qquad\qquad\qquad (3.42) \qquad\quad (.46)$

$\bar{R}^2 = .89 \qquad SE = .63$

(22) $QPT_t = 23.23 + .4330\ QPT_{t-1} + 4.690\ RPT_{t-1}$
$\qquad\qquad\qquad (2.43) \qquad\quad (3.18)$

$\bar{R}^2 = .90 \qquad SE = 119.6$

Equations (20), (21) and (22) were derived from statistics for 1960-70 on sweet and white potatoes. The yield and production data were converted to a grain equivalent basis. The RPT variable is an index of gross returns per hectare (deflated) with a base of 1965 = 100.

Gross returns per hectare did influence area in potatoes as shown in Equation (20) but apparently did not have a measurable effect on yields as indicated by Equation (21). Area in potatoes expanded rapidly following sharp price increases in 1963 and 1964 and then dropped back somewhat in the late 1960s as the combination of prices and yields failed to keep pace with inflation.

If the index of gross margins were held at the average level for 1967-69, area in potatoes would continue to decline to about 159,000 hectares by 1985.

This compares with 182,000 hectares in 1970. If gross returns were to be increased by 10 percent, the area would still decline but only to 175,000 hectares. This implies a long run supply elasticity of .95.

Yields on potatoes would decline to 3.78 MT per hectare by 1985 if gross returns do not change from the 1967-69 level. A 10 percent increase in gross returns would raise the projection to 4.02 MT, about average for recent years. This means that the supply elasticity with respect to yields is about .63. Combining Equations (20) and (21) would result in a projection of 600,000 MT at equilibrium assuming 1967-69 gross returns and 702,000 MT assuming 10 percent higher gross returns.

Using the production Equation (22), the projection to 1985 is 597,000 MT at 1967-69 gross returns and 653,000 MT at gross returns 10 percent higher. These figures compare with a production level of about 770,000 MT for 1968-70. The long run supply elasticity would figure out to be about .92 based on the production equation and 1.70 based upon the combination of Equations (20) and (21).

Vegetables

$$(23)\quad AVG_t = -11.75 + \underset{(2.78)}{.8614}\, AVG_{t-1} + \underset{(1.38)}{.5073}\, RVG_{t-1}$$

$$\bar{R}^2 = .44 \qquad SE = 26.1$$

$$(24)\quad YVG_t' = 7.49 + \underset{(2.86)}{.2761}\, T$$

$$\bar{R}^2 = .44 \qquad SE = .88$$

$$(25)\quad QVG_t = -211.5 + \underset{(11.78)}{1.145}\, QVG_{t-1} + \underset{(1.10)}{1.650}\, RVG_{t-1}$$

$$\bar{R}^2 = .94 \qquad SE = 103.8$$

The aggregate statistics on vegetables were available for 1960-69. An index (1965 = 100) was calculated for the deflated gross returns per hectare.

This index was not a significant explanatory factor in the equations on area, yields and production , however.

Using Equation (23), projected area at equilibrium would be 262,000 hectares with the index of gross returns remaining at the 1966-68 average of 94.6. This would be above the 226,000 hectares of 1969. A 10 percent increase in gross returns would raise the equilibrium level to 296,000 hectares. This implies a long run elasticity of 1.32 on area. A significant upward trend on yields was noticed, but no significant relationship of gross returns on yields was established, therefore, the elasticity with respect to area can be considered as the long run supply elasticity.

The upward trend in yields would be expected to reach 15.8 MT/ha by 1985 compared with 11 MT in 1968 and 1969. Combined with projected acreage, this would be around 4,150,000 MT or 4,670,000 MT depending on the assumption on gross returns.

The formula to estimate equilibrium levels cannot be applied to Equation (25) because the coefficient on the lagged dependent variable (QVG_{t-1}) is greater than one. The implication is that the upward trend in vegetable production would continue without reaching an equilibrium. One could calculate the production level at any year in the future, such as 1985, by recursive computation. When this was done, the results were not acceptable since the 1985 projections were 18,221,000 MT and 19,053,000 MT depending on the gross returns assumption. The different results from Equations (23) and (24) relative to Equation (25) seems to be due to an inverse correlation between harvested area and yields. Because of the relatively short period analyzed (10 years) and the acceleration in production in recent years, the projections to 1985 based on Equation (25) are unrealistically high. In fact recent low prices (considerably lower than assumed in this analysis for the longer run) will likely restrain production if not actually causing a reduction.

Future expansion in vegetable area may shift toward winter production under polyethylene-type structures. This would seem to be particularly promising on single paddy land where there is no alternative use of the land in winter.

Fruit

(26) $AFR_t = -31.8 + 1.063\ AFR_{t-1} + .329\ RFR_{t-1}$

$$\begin{array}{ll} (19.10) & (5.80) \\ \bar{R}^2 = .98 & SE = 2.0 \end{array}$$

(27) $YFR_t = 7.3 + .01672\ T$

$$\begin{array}{ll} (.29) & \\ \bar{R}^2 = -.11 & SE = .53 \end{array}$$

(28) $QFR_t = -111.3 + 1.039\ QFR_{t-1} + 1.262\ RFR_{t-1}$

$$\begin{array}{ll} (9.50) & (1.50) \\ \bar{R}^2 = .91 & SE = 29.8 \end{array}$$

Aggregate data on fruit were available for 1960-69. An index of deflated gross returns per hectare was calculated using 1965 = 100.

The short time span of available data restricted the form of the supply equation. Ideally, one would prefer to examine lags of 5-10 years on tree fruits. A one year lag on the profit variable can only pick up a marginal response to returns. The lagged dependent variable, of course, does pick up the influence of previous years. The relatively high and significant value of the coefficient on this variable in Equations (26) and (28) indicates the importance of forces in earlier years in explaining the level of area and production in year t.

As on vegetables, the projected equilibrium values for area and production cannot be calculated. On area, continuation of gross returns at 1966-68 levels would result in 160,000 hectares being harvested in 1985 compared with 55,700 hectares in 1969. At returns 10 percent higher, the harvested area would reach 244,000 hectares by 1985. This means the elasticity of supply with respect to area would be about 5.25. Combined with projected yields of 7.8 MT/hectare, production would reach 1,248,000 MT and 1,903,000 MT respectively, compared with 417,000 MT in 1969. From Equation (28), projected production would reach 1,039,000 MT by 1985 at 1966-68 gross returns and 1,206,000 MT at 10 percent higher gross returns. A 2.57 long run supply elasticity would be derived from Equation (28). The results from Equation (28) appear more reasonable than from Equation (26), though both indicate a substantial increase in production even at recent levels of return.

Cocoons

$$(29) \quad ACN_t = -6.56 + \underset{(6.33)}{.8548\ ACN_{t-1}} + \underset{(1.57)}{.000586\ RCN_{t-1}}$$

$$\bar{R}^2 = .86 \qquad SE = 9.74$$

$$(30) \quad YCN_t = 74.78 + \underset{(1.55)}{.4991\ YCN_{t-1}} + \underset{(.62)}{.000613\ RCN_{t-1}}$$

$$\bar{R}^2 = .12 \qquad SE = 30.9$$

$$(31) \quad QCN_t = -2.10 + \underset{(8.71)}{1.0765\ QCN_{t-1}} + \underset{(1.31)}{.000086\ RCN_{t-1}}$$

$$\bar{R}^2 = .92 \qquad SE = 1.62$$

The area in mulberry in any given year is tied closely to the area in production the year earlier since the growth period on mulberry trees is about three years. Even so, sharp year to year changes in the harvested area do occur. The influence of returns per hectare lagged one year on the area in mulberry was not significant at the 5 percent level, however.

Yields per hectare have been quite variable and have not been affected very much by gross returns. The equilibrium projection is nearly 200 kg/hectare with an elasticity of about .25.

The equation on production of cocoons (31) has properties similar to the equation on area (29) except that the coefficient on the lagged production variable is greater than one. This precludes an equilibrium solution.

Using Equation (29), the projected equilibrium area would be 110,000 hectares with gross returns at average levels for 1967-69. At 10 percent higher gross returns, the equilibrium projection would be 125,300 hectares. This suggests a long run supply elasticity of 1.41. The combined effect of Equations (29) and (30) projects equilibrium production at 21,547 MT at 1967-69 gross returns and 25,174 at 10 percent higher returns. This adds up to a long run supply elasticity of 1.68. Using Equation (31), current gross returns would result in a projection of 96,400 MT by 1985; while 10 percent higher returns would raise the projection to 102,900 MT, ie. a long run supply elasticity of .67. The area projections compare with about 85,000 hectares in 1970 and the production projections compare with around 121,000 MT in 1970. The projections from Equations (29) and (30) seem low and the projections from Equation (31) seem high in comparison with recent trends in the sericulture industry.

Direct subsidies are paid to the mulberry and cocoon industry. The amounts actually received by the various segments of the industry are not known. Total government expenditure in the program for the sericulture industry reached a peak of W1480 million in 1968 and 1969, then dropped back to W936 million in 1970. This compares with W5,300 million in market sales by cocoon producers in 1968, W7,200 million sales in 1969 and W7,000 million sales in 1970. The point is that the direct subsidy is an important element in the sericulture economy.

The annual amount of government expenditures was included as an additional variable in the supply equations. The results were as follows:

$$(32)\quad ACN_t = -3.60 + \underset{(7.13)}{.6532\ ACN_{t-1}} + \underset{(.93)}{.000221\ RCN_{t-1}} + \underset{(4.72)}{.0399\ GCN_t}$$

$$\bar{R}^2 = .95 \qquad SE = 5.85$$

$$(33)\quad QCN_t = -1.75 + \underset{(13.34)}{.9794\ QCN_{t-1}} + \underset{(.25)}{.000010\ RCN_{t-1}} + \underset{(5.05)}{.116213\ GCN_t}$$

$$\bar{R}^2 = .97 \qquad SE = .93$$

The statistical properties of Equations (32) and (33) were improved over (29) and (31). The government expenditure variable (GCN_t) was quite significant. Using Equation (32), the projection at equilibrium is 104,000 hectares assuming 1967-69 gross returns and government expenditures; 106,000 hectares if gross returns are increased 10 percent; 113,000 hectares if government expenditures are increased 10 percent and 115,000 hectares if both are increased 10 percent. In combination with projected yields, the output would be 20,300 MT, 21,400 MT, 22,700 MT and 23,200 MT respectively. This would represent only a small increase of actual 1969-70 levels.

Using Equation (33), the projected output would be 61,000 MT in 1985 assuming 1967-69 gross returns and government expenditures; 61,500 MT if gross returns were increased by 10 percent; 67,200 MT if government expenditures were increased by 10 percent and 67,700 MT if both were increased by 10 percent. These levels would be about triple those of 1969-70.

The discrepancy between the results from the acreage and yield equations versus the production equation seems to be due to the inverse correlation between harvested area and yields, as was the case on vegetables. This would suggest that a decline in area is not entirely a response to lower prices since higher yields partially offset the reduced area. For this reason, a compromise projection was made using Equation (32) for area and assuming that yields would increase from 209 and 252 kg/hectare in 1969 and 1970 to 300 kg by 1985. This would increase production to 31,200 MT and 34,500 MT under the alternative assumptions about returns and government expenditures.

Recalculating the long run supply elasticities with respect to gross returns from the market, Equation (32) yields a figure of .24. The elasticity with respect to government expenditures would be .87. If both gross returns and government expenditures change by the same percentage, the elasticity would be 1.10. From Equation (33), the long run elasticity of supply with respect to price would be .09, and with respect to government expenditures would be 1.03. If both gross returns and government expenditures change by the same percentage, the elasticity would be 1.11.

The relative importance of the government payments to cocoon producers income cannot be determined precisely. Assume that it represents 10 percent of gross sales. Gross income would then be 110 percent of gross sales. A 10 percent increase in gross sales would increase gross income by 9 percent. A 10 percent increase in the direct payments would increase gross income by .9 percent. From the elasticities derived from Equations (32) and (33), it would appear that producers are more responsive to government payments than to market sales, especially when their relative importance is taken into account.

Tobacco

Tobacco area doubled in the 1960s from around 20,000 hectares to 40,000 hectares. No consistent trend was detected on yields nor deflated prices. Even though only 9 years of data were available for analysis, a significant response to price was noted.

$$(34)\quad ATB_t = -5.50 + \underset{(10.58)}{.9773\ ATB_{t-1}} + \underset{(2.56)}{.07292\ PTB_{t-1}}$$

$$\bar{R}^2 = .93 \qquad SE = 1.95$$

$$(35)\quad QTB_t = -20.07 + \underset{(4.93)}{.8273\ QTB_{t-1}} + \underset{(2.40)}{.2654\ PTB_{t-1}}$$

$$\bar{R}^2 = .74 \qquad SE = .86$$

Equations (34) and (35) indicate somewhat different equilibrium levels for the industry—81,230 hectares from Equation (34) and 38,510 metric tons from Equation (35). The 81,000 hectares represents a substantial increase from 1970 and the 38,510 metric tons represents a substantial decrease. Both equations, however, suggest a long run price elasticity of supply of 4.0. Because of the short time span of the time series, such estimates can only be very general, suggesting that the supply of tobacco is elastic.

Milk

Milk production has been negligible in Korea but has increased sharply in recent years. Production jumped from 10,000 MT in 1965 to over 50,000 MT in 1970. The number of milk cows and replacements was about 23,000 head in 1970 compared with 1,271,000 head of Korean cattle (draft).

Using data for 1961-70, a graphic analysis was made of the relationship between the deflated gross returns per cow in one year and the number of cows on farms the following year. The relationship was positive and significant with an elasticity (at recent levels of gross returns and dairy cattle numbers) of about 1.0. However, government programs to encourage the dairy industry have undoubtedly contributed to this growth. For this reason, and because of the infancy of the industry, a statistical analyses was not attempted.

Beef

The number of Korean cattle (draft) on farms increased from the mid 1950s to the mid 1960s and stabilized at around 1,200,000 to 1,300,000 head. These figures include both adult cattle and calves. Female animals represent about two thirds of the total. Taking the 1,271,000 head of Korean cattle on farms on December 31, 1970, about 850,000 would be females. If the average slaughter age is 7 years, approximately 660,000 would be adult females and the remainder would be replacement heifers and heifer calves. One fifth of the adult females would be slaughtered if the cattle population were stabilized, i.e. about 130,000 head.

Estimates show that Korean cows have about a 50 percent calving percentage each year. This means that recent calf crops have been about 330,000 head per year. Nearly all the females would be needed for replacement purposes. According to practice, the bull calves are usually raised to 2 years of age and then slaughtered. This would add up to about 115,000 head per year.

From this arithmetic, one would estimate annual slaughter to be composed of about 130,000 cull Korean cows, about 115,000 head of 2 year old bulls and a small number of herd bulls. This totals up to around 250,000 head slaughtered per year from an inventory of 1,271,000 head (December 31, 1970). The average number of Korean cattle on farms in the five year period of 1964-68 was very close to 1,271,000 and inspected cattle slaughter in 1965-69 averaged nearly 250,000 head.

There is some belief, however, that the inspected slaughter figure may understate the actual slaughter. There is some incentive for "illegal" slaughter particularly when cattle prices are high. This is because retail beef prices are controlled. One additional source of slaughter in 1965-69 was a slight liquidation of Korean cattle. The number dropped from 1,351,000 on December 31, 1964 to 1,202,000 on December 31, 1969. This amounted to 30,000 head per year. In addition, there were about 5,000 head of dairy cattle on farms at the beginning of this period and 19,000 at the end plus one to four thousand head of beef cattle. If these figures are correct, there may be some 30-35,000 head of cattle slaughtered which are not counted in the inspected statistics.

In any case, the decision was made to analyze the beef production data rather than cattle numbers since some attempt is made to incorporate estimates of illegal slaughter in the production statistics. MAF assumes a live weight of 350 kg per head and a conversion of 35 percent to a retail weight. In other words, each animal is assumed to produce 122.5 kg of beef, retail weight equivalent.

(36) $$QBF_t = -2.67 + .7503\ QBF_{t-1} + .03735\ PBF_{t-1}$$
$$\qquad\qquad\qquad\quad (3.93) \qquad\qquad\quad (1.29)$$

$$\bar{R}^2 = .82 \qquad\qquad SE = 4.00$$

The quantity of beef produced (QBF) is in terms of retail weight equivalent and the price of beef is a deflated farm price converted to a retail weight equivalent. The price was calculated by taking the price per head and dividing by the retail weight (122.5 kg) to obtain a farm price per kg at retail. This price was, of course, deflated by the index of prices paid by farmers.

The impact of beef prices on production was not significant at the 5 percent level. This is not surprising since cattle are kept on Korean farms primarily for draft purposes. The major impact of higher beef prices would be to accelerate culling for a period or perhaps encourage the feeding of concentrates over a longer period. Most of the animals do go through a feeding period prior to slaughter.

At equilibrium, assuming prices equivalent to the 1967-69 average, beef production would increase to 43,200 MT compared to 37,300 MT in 1970. At 10 percent higher prices, the equilibrium output would be 48,500 MT, implying a long run supply elasticity of 1.24.

In the future, the elasticity may increase in the short run and decline or even turn negative in the long run. Higher prices on Korean cattle would encourage more farmers to sell off cattle and mechanize. To date, the level of mechanization has been too small to have a major impact on cattle numbers. There could well be a conflict of interests between farmers wishing to sell cows for slaughter and government programs to build cattle numbers from Korean stock. Even now, the government prohibits slaughtering female animals at less than 5 years of age and male animals at less than 2 years. As the need for Korean draft cattle wanes, there is a real question as to whether extensive operations on hills and/or intensive operations using imported concentrates can economically sustain and expand the cattle population in Korea.

Pork

Pork production in Korea is primarily traditional, with one or two sows per farm, being fed on garbage and by-products. Wheat bran would be the major grain product fed. Sows farrow twice a year and average about 8 pigs per farrowing, saving about 6.4 on the average. One would not expect farmers to be particularly responsive to hog prices nor to hog prices relative to prices on grain and grain products.

(37) $$QPK_t = 19.27 + \underset{(.10)}{.01989\ QPK_{t-1}} + \underset{(3.20)}{.2947\ PPK_{t-1}}$$

$$\bar{R}^2 = .43 \qquad SE = 10.5$$

Somewhat surprising was the significant coefficient on the price of pork variable, which is the farm price on a retail weight equivalent. (Prices per head were converted to a retail equivalent by assuming 40 kg of pork from the average 80 kg live hog marketed.) The low value on the coefficient for QPK_{t-1} indicates that farmers fully adjust to a change in price in about a year.

The equilibrium output assuming 1967-69 prices would be 74,400 MT compared with 76,100 MT in 1970. At 10 percent higher prices, pork production would stabilize at about 80,000 MT. The implied long run supply elasticity is .74.

An attempt was made to measure the combined effect of hog prices and wheat prices on pork production. In one equation, pork prices were divided by wheat bran prices. In another equation, the price of pork (retail weight equivalent) minus 10 times the price of wheat bran was deflated. The factor of 10 was the estimate of the conversion of wheat bran to pork (retail weight). Neither equation improved upon Equation (37), however.

<u>Poultrymeat</u>

Poultrymeat production doubled in the past 5 years largely due to specialized intensive broiler operations. One estimate is that in 1969, 44.5 percent of the poultrymeat production was from light and heavy broilers. Another estimate is that 26 percent of the chickens in the year end inventory count are broilers and 74 percent are layers and egg-type pullets. Since layers are often held for several years, there would likely be a substitution effect between egg prices and poultrymeat production. As egg prices fall, closer culling of flocks would be expected. Higher egg prices would encourage holding layers longer. The supply analysis confirmed this effect.

$$(38) \quad QPM_t = 1.56 + \underset{(3.47)}{.4718}\, QPM_{t-1} + \underset{(6.25)}{.2405}\, PPM_{t-1} - \underset{(-4.56)}{.3398}\, PEG_{t-1}$$

$$\bar{R}^2 = .94 \qquad\qquad SE = 2.12$$

The variable PPM is the deflated price of poultrymeat in retail weight equivalent. A price series was constructed from a per head price on hens. In deriving government statistics, a 1.6 kg live weight is assumed of which 70 percent is carcass weight. This converts to 1.1 kg retail weight per bird. The deflated price of eggs is on a per kg basis.

Assuming egg and poultrymeat prices at their 1966-68 levels, poultrymeat production would reach an equilibrium at 41,000 MT, about the same level of output as in 1969-70. At poultrymeat prices 10 percent higher, the output would eventually stabilize at 52,000 MT. This implies a long run supply elasticity of 2.6. If egg prices were raised 10 percent, the equilibrium poultrymeat output would decline to 31,000 MT. The long run cross elasticity of supply on poultrymeat with respect to egg prices would be about -2.3.

The elasticities look reasonable but the projections appear somewhat low. An alternative form of the equation using serial time resulted in the following estimates:

$$(39)\quad QPM_t = 15.34 + \underset{(3.01)}{.7067\,T} + \underset{(7.22)}{.2660\,PPM_{t-1}} - \underset{(-7.73)}{.4648\,PEG_{t-1}}$$

$$\bar{R}^2 = .93 \qquad SE = 2.28$$

This equation would project poultrymeat production to 46,000 MT by 1985 under 1966-68 prices and 53,600 MT at 10 percent higher prices on poultrymeat. This would represent a long run supply elasticity of 1.65.

Because of the apparent rapid change in the poultry industry in recent years to a more commercialized basis, two changes were made in the supply analysis. Instead of using data going back to 1956, the analysis was confined to 1961 to 1970. The second change was to substitute an estimated gross margin per kg over feed costs in place of the price of poultrymeat. The effect of the first change was as follows:

$$(40)\quad QPM_t = -5.12 + \underset{(4.90)}{.7954\,QPM_{t-1}} + \underset{(3.70)}{.1851\,PPM_{t-1}} - \underset{(-2.26)}{.2396\,PEG_{t-1}}$$

$$\bar{R}^2 = .94 \qquad SE = 2.82$$

In view of the shorter time period examined (10 years) this equation compared favorably with Equation (36). The projected value of QPM at equilibrium would be 67,000 MT and 93,000 MT at 10 percent higher poultrymeat prices. These would seem to be more reasonable projections for 1985. The long run supply elasticity would be 3.90 with respect to poultrymeat prices. With respect to egg prices, the long run elasticity was -2.52.

The second change was to convert the poultrymeat price variable to a gross margin over feed costs. A price of broiler feed was constructed using actual prices for 1968-70 and an index of feed prices paid by farmers for 1960-67. Assuming that about 3 kg of concentrate feed was used per kg of broiler meat (retail) produced, a feed cost per kg of broiler meat was estimated. The difference between broiler prices and feed costs was then deflated to calculate the gross returns over feed costs (RPM).

$$(41)\quad QPM_t = 2.23 + \underset{(4.50)}{.8485\, QPM_{t-1}} + \underset{(2.84)}{.1657\, RPM_{t-1}} - \underset{(-1.57)}{.1853\, PEG_{t-1}}$$

$$\bar{R}^2 = .91 \qquad\qquad SE = 3.34$$

While satisfactory, this equation did not have statistical properties as favorable as Equation (40). Feed costs apparently did not influence production. This was also established in an equation with feed prices as an independent variable. Equation (41) projects production to 75,000 MT at equilibrium assuming 1967-69 gross returns over feed costs and to 97,000 MT at 100 percent higher returns. This would be a long run elasticity of 2.93.

Eggs

As with poultrymeat, egg production has increased sharply in recent years, also doubling in the past 5 years. While there are still small flocks scavenging on small farms, the production is rapidly becoming concentrated in intensive units. A time series analysis was not successful in identifying any significant relationship between prices (or gross margins over feed costs) on eggs and production. If anything, there was a positive relationship between poultrymeat prices and egg production.

Particularly surprising has been the rapid expansion in 1965-70, a period in which deflated egg prices were declining. Egg prices also declined relative to feed costs. The reason for this anomaly deserves further study.

Chapter III

Matrix of Long Run Supply Elasticities

Based on the foregoing analysis, a set of own-price elasticities were selected and placed in a matrix representing all possible combinations of own-price and cross elasticities of supply (Table 1).[11] The only successful attempt at measuring a cross elasticity by statistical means was on poultry-meat production relative to egg prices and to a lesser extent, the effect of barley prices on wheat production. The difficulty in using statistical analysis to isolate cross elasticity effects is due primarily to the short time period of the time series and the intercorrelation among the independent variables.

Many of the cross elasticities may be assumed to be low or zero. On rice, there are no close substitutes in production. Some complementarity might be expected between rice production and production of winter barley, winter wheat and winter vegetables. Substitution between barley and wheat should be relatively close, though returns per hectare from barley have been well above those for wheat in recent years. Some substitution effect might be expected among the summer crops of other cereals, pulses, potatoes, vegetables, mulberry and tobacco. Some substitution effect would also be expected between milk and beef production in competing for roughage. Other cross elasticities might be expected to be insignificant.

The question is "How can the more important cross elasticities be measured?" One approach might be to draw upon budgeting or linear programming studies which include the relevant enterprises. This approach and/or the

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[11] These elasticities were judged to be reasonable by certain staff members in the Ministry of Agriculture and Forestry though somewhat on the low side.

Table 1. Matrix of Long Run Supply Elasticities in Korean Agriculture

Price Effect of ↓	On the Supply of: Rice	Barley 1/	Wheat 1/	Other Cereals	Pulses	Potatoes	Vegetables	Fruit	Cocoon 2/	Tobacco	Milk	Beef	Pork	Poultry-meat	Eggs
Rice	.15														
Barley 1/		.85	-1.10												
Wheat 1/			.46												
Other Cereals				.42											
Pulses					.88										
Potatoes						.95									
Vegetables							1.32								
Fruit								2.57							
Cocoon 2/									1.11						
Tobacco										4.00					
Milk											1.00				
Beef												1.24			
Pork													.74		
Poultry-meat														3.90	+
Eggs														-2.52	0

1/ Barley, wheat and rye in the aggregate had an own-price elasticity of supply of .90.

2/ Price and government expenditures.

soliciting of the judgement of researchers and recognized authorities might be sufficient.

An alternative on crops is to use the area elasticities. By setting the total area at some fixed level, the area displaced by one crop (according to its own price elasticity) would be allocated to the other crops by a weighting procedure. This weighting procedure might be based on the relative level of their current or projected area.

For example, potatoes are expected to occupy 159,000 hectares in 1985 if recent 3 year average returns prevail. The long run price elasticity on potatoes with respect to area was .95. If potato returns were raised 10 percent, the area in potatoes would increase by 16,000 hectares to 175,000 hectares in 1985. If the total area in summer crops of other cereals, pulses, potatoes, vegetables, mulberry and tobacco were expected to reach 1,041,000 hectares in 1985, then 866,000 hectares would be available for crops other than potatoes. The projection, however, (assuming recent returns for all crops) is to 882,000 hectares by 1985. The 16,000 hectares taken by potatoes must be shifted from the other crops. One way to decide the allocation of this shift is to base it on the area. The area in pulses was projected to 372,000 hectares. This represents 42.4 percent of 882,000 hectares. The projection on pulse area would then be reduced by 42.4 x 16,000 hectares or 6,752 hectares. This represents a reduction of 1.82 percent in the projected pulse area. Therefore the cross elasticity of the supply of pulses relative to potato returns would be -.182. The other cross elasticities could be calculated in a similar fashion.

As a suggested procedure in computing the cross elasticities, as many of the cells should be filled in from <u>a priori</u> information as possible. The cross elasticities for the remaining cells could be calculated by the procedure outlined.

Chapter IV

Projections

As a by-product of the calculation of long run supply elasticities, a set of projections was calculated on area of crop land and production of crops and livestock. These projections to 1985 are presented in Tables 2 and 3. They need to be considered as a part of the process of estimating elasticities rather than the most likely projections to 1985. The production projections were derived from the regression analysis but with some judgement added.

The final projections should take into account the most likely prices, returns, the cross elasticities and new technical developments. Nevertheless, the projections in Tables 2 and 3 do indicate something of the prospective developments assuming continuation of recent price levels and alternatively assuming 10 percent higher prices. In both cases, no major technological breakthroughs are taken into account such as IR 667.

Table 2. Area of Crop Land in Selected Years with Projections to 1985, Korea

	1955	1960	1965	1970	1985 At recent 3 yr average returns	1985 At 10 perce higher retu
			Area in 1000 Hectares			
Rice	1098	1130	1238	1213	1203	1222
Barley	760	799	1031	911	932	982
Wheat	122	125	153	159	102	105
Other cereals	—	207	216	124	84	87
Pulses	314	321	368	368	372	382
Potatoes	—	108	214	182	159	175
Vegetables	108	118	151	226[1/]	262	296
Fruit	19.6	12.5	42.9	55.7[1/]	133	167
Mulberry	32.4	20.4	50.5	85.0	104.0	115.0
Tobacco	—	20.2[2/]	34.4	43.0	81.2	113.6
Total of above	—	2871.1	3498.8	3366.7	3432	3645
(Barley, wheat and rye[3/])	916	959	1210	1084	1080	1140

[1/] 1969.

[2/] 1961.

[3/] From separate equation.

Table 3. Production in Selected Years with Projections to 1985, Korea

	Production in 1000 MT					
	1955	1960	1965	1970	1985	
					At recent 3 yr average returns	At 10 percen higher retu
Rice	2959	3947	3501	3939	4500	4600
Barley	1041	1370	1807	1974	1874	2050
Wheat	200	258	300	357	324	338
Other cereals	—	81	120	124	126	131
Pulses	168	150	203	277	288	310
Potatoes	—	326	1046	783	600	675
Vegetables	—	1088	1576	2427 1/	4150	4670
Fruit	—	166	310	417 1/	1039	1306
Cocoon	6.5	4.6	7.8	21.4	31.2 2/	34.5 2/
Tobacco	—	31.5 3/	56.1	56.3	122 4/	170 4/
(Barley, wheat and rye)	1273	1668	2136	2352	2200	2400
Milk	—	—	10.1	51.9		
Beef	11.0	12.6	27.3	37.3	43.2	48.5
Pork	24.4	58.0	55.9	79.2	74.4	79.9
Poultrymeat	6.1	18.1	14.5	44.7	67.0	93.0
Eggs	16.7	41.0	42.8	138.0		

1/ 1969.

2/ Assuming yields of 300 kg/ha.

3/ 1961.

4/ Assuming 1.5 MT/ha

Chapter V

Summary and Conclusions

Korean farmers do respond directly to price, gross returns, and other measures of profit. Of the 14 commodities analyzed by linear regression techniques, only on "other cereals" (mostly corn and millet), vegetables, eggs and beef were the coefficients on the profit variable not significant at the 5 percent level in any of the formulations of the supply equations. Even so, the coefficients on these products except for eggs did carry the correct sign. The profit variable (gross returns) was not significant on cocoons, but the subsidy variable was. A regression analysis was not undertaken on milk.

The extent of the response as measured by long run price elasticities of supply ranged from about .15 on rice to around 4 on tobacco and poultrymeat. Barley, wheat and rye in the aggregate, pulses, vegetables and potatoes had long run price elasticities of supply of about one, as did cocoons, milk and beef. Fruit had an elasticity of about 2.5 and pork had an elasticity of about .75.

Underlying the supply picture are certain strong trend factors which need to be taken into account in appraising the future. Area in rice has been edging lower in recent years as has area in all crops combined. Production, however, is likely to continue to increase on rice, vegetables, fruit, cocoon, tobacco, milk, beef, eggs and poultrymeat even without further increases in real prices and returns. On the other hand, production of barley, wheat, potatoes, and possibly pork would decline if recent real prices and returns would continue.

While many implications can be drawn from this working paper in conjunction with other working papers, some of the more important ones are as follows.

1. Prospects for self-sufficiency in rice appear dim unless IR 667 is an acceptable variety to consumers and in fact does have superior yielding ability. With ample world supplies of cereals in prospect, the Korean government should weigh very carefully the value of increased subsidization and higher real prices for rice.
2. Expanding barley, wheat and rye into single crop paddy regions through earlier maturing varieties is an attractive alternative. With falling world wheat prices, would it be preferable to shift wheat to barley and buy needed wheat from world markets? Gross returns from wheat have been less than from barley in Korea.
3. Market price relationships and costs will dictate shifts among "other cereals," pulses, potatoes, and vegetables. A good outlook program could help guide farmers in allocating land to these crops and avoid or mitigate over and under supply problems. The focus would be on the short term outlook.
4. Longer term outlook and planning are important for export crops such as silk and tobacco. More direct government involvement to foster market analysis, development of processing facilities and marketing institutions might be appropriate. Even with the longer term nature of these industries, a fair degree of short term flexibility in production has been demonstrated.
5. Possibilities for the livestock industries are difficult to assess. Technology is readily transferable into egg and poultrymeat production. The same potential exists for pork, but so far this

enterprise has remained traditional. Beef production is primarily based on Korean cattle. If cattle numbers decline, as is likely, sources of indigenous beef will wane without substantial government effort to develop pastures. Milk production will likely be on an intensive basis, particularly for fresh milk. Land near population centers is too expensive for pasturing.

6. For export earnings, there may be some new specialty crops which should be explored. Korea might well capitalize on its well educated and trained population by producing, processing and marketing those specialty crops requiring both low cost labor and high technical skills. Perhaps more emphasis on agricultural marketing and promotion might be needed to engineer such an endeavor.

APPENDIX A

TABLE A.1 SELECTED ANNUAL DATA ON RICE, KOREA

Year	Planted Area 1000 Hectare	Yield MT/ha	Production 1000M/T	Average Price Received by farmers in Nov_t to Jan_{t+1} polished, grade B (or 1st grade)			Average Price Received by farmers in Nov_t to $April_{t+1}$ weighted by Marketings in the narrow sense, polished grade B (or 1st grade)			Gross Returns per ha based on NOV_t to Apr_{t+1} prices	Total Prod. Cost per ha	Total Prod. Cost-cost of labor, cap. & land ser.	Total Prod. Cost-cost of self ser. inputs[3/]	Gross Return-(Total production cost-cost of self ser. inputs)		Average Rainfall in 7 Provinces in May & June[5/]	Area of Rice Not Fully Irrigated		
				W/100 l	W/kg	Deflated W/kg[1/]	W/100 l	W/kg	Deflated W/kg[1/]	W/ha	W/ha	W/ha	W/ha	W/ha	Deflated[1/] W/ha	mm	Part. Irr. Paddy	Rain Field	Par Irr Rai Fie
Regression Code	[illegible]	YRC	QRC						PRC						MRC	W	1000ha		
1955	[illegible]	2.50	2959	787[2/]	9.838	32.26	858	10.7	35.1	28783	23470	8230	13600[4/]	15183	49780				
1956	[illegible]	2.20	2433	1451[2/]	13.138	48.24	1556	19.5	51.9	42900	28050	9600	18890[4/]	24010	63860	70.1			
1957	[illegible]	2.69	3002	1121[2/]	14.013	30.27	1196	15.0	32.4	40350	38910	11650	28410[4/]	11940	25790	97.6			
1958	[illegible]	2.83	3161	1042[2/]	13.025	29.20	1066	13.3	29.8	37639	37940	11650	26710[4/]	10929	24500	63.4			
1959	[illegible]	2.81	3150	957	11.963	24.97	1017	12.7	26.5	35687	37570	13340	14380[4/]	21307	44480	84.4			
1960	[illegible]	2.69	3047	1340	16.750	32.59	1400	17.5	34.0	47075	36470	12150	16220[4/]	30355	60030	155.5			
1961	[illegible]	3.04	3463	1404	17.550	31.62	1422	17.8	32.1	54112	48740	12590	19240[4/]	34872	62830	113.1	283	231	514
1962	[illegible]	2.63	3015	1814	22.675	36.93	1650	23.1	37.6	50753	44790	13280	17180[4/]	43593	70970	64.6	278	219	497
1963	[illegible]	3.23	3758	2635	32.938	48.37	2789	34.9	51.2	112727	58630	17530	21930	90797	133330	342.3	284	215	499
1964	[illegible]	3.28	3954	3032	37.900	43.82	3028	37.9	43.8	124312	80660	23550	29 60	94352	109080	96.6	289	207	496
1965	[illegible]	2.83	3501	2983	37.288	37.29	3010	37.6	37.6	106408	93450	26010	37460	68948	68950	43.6	301	200	501
1966	[illegible]	3.16	3919	3140	39.250	34.98	3244	40.6	36.2	128296	97070	25740	38010	90286	80470	106.9	291	181	472
1967	[illegible]	2.89	3603	3632	45.400	35.75	3722	46.5	36.6	134385	109230	30750	42430	91955	72410	98.7	281	178	459
1968	[illegible]	2.75	3195	4932	61.713	40.55	4966	62.1	40.8	170775	126600	39510	51680	119095	78250	46.2	254	145	399
1969	[illegible]	3.33	4090	5354	65.675	39.16	5427	67.8	40.4	225774	145870	48110	60400	165374	98610	118.0	250	141	391
1970	1213	3.25	3939	6596	82.450	42.70	6650	83.1	43.0	325831						142.5			
1971																154.7			

1/ Deflated by index of prices paid by farmers 1965 = 100

2/ .95 times price of 1st grade in pricing area of origin, all cities

3/ Self Service refers to inputs produced on the farm

4/ Based on [illegible].5 times (total production cost-cost of labor, capital and land service)

5/ Provinces included such cities as Chunchon, Seoul, Daegen, Jeonju, Gwanju, Busan, Mokpo

TABLE A.2 SELECTED ANNUAL DATA IN SPECIFIED REGIONS IN KOREA

Year	PROVINCES IN DOUBLE PADDY CROPPING REGION				PROVINCES IN SINGLE PADDY CROPPING REGION				PROVINCES IN UPLAND CROPPING REGION			
	Planted Area	Yield	Production	Rainfall In May-June In 8 Provinces	Planted Area	Yield	Production	Rainfall In May-June In 3 Provinces	Planted Area	Yield	Production	Rainfall May-June 2 Provinc
	1000 ha	MT/ha	1000 MT	mm	1000 ha	MT/ha	1000	mm	1000 ha	MT/ha	1000	mm
1955	682.7	2.819	1924.2	60.3	309.6	2.515	778.6	182.9	106.0	2.417	256.2	145.6
1956	684.2	2.180	1491.8	221.0	315.1	2.330	734.2	220.2	105.7	1.983	211.6	137.2
1957	688.0	2.761	1839.6	129.3	315.8	2.621	827.7	41.8	110.4	2.486	274.5	28.7
1958	688.5	2.894	1992.4	84.0	317.6	2.841	902.3	26.8	111.5	2.387	266.2	34.8
1959	688.6	2.771	1908.1	86.4	321.1	2.922	938.4	75.7	112.6	2.691	303.0	59.6
1960	695.0	2.524	1754.1	133.6	322.6	3.005	969.4	195.3	112.8	2.865	323.2	175.7
1961	699.8	3.063	2143.6	117.9	325.0	3.048	990.5	123.9	112.7	2.914	328.4	88.0
1962	703.3	2.627	1847.6	71.7	322.8	2.672	899.4	58.6	112.4	2.470	277.6	30.3
1963	710.0	3.294	2338.5	376.6	333.8	3.209	1071.1	255.8	121.1	2.877	348.5	145.8
1964	734.7	3.339	2453.4	108.4	343.3	3.266	1121.1	90.7	127.2	2.987	380.0	161.3
1965	757.3	2.951	2234.9	60.1	351.2	2.693	945.7	21.2	129.9	2.468	320.6	57.4
1966	755.5	3.312	2502.5	112.4	354.5	3.027	1073.0	76.3	131.5	2.614	343.7	132.3
1967	759.0	2.820	2140.3	104.5	353.6	3.155	1115.7	92.1	132.9	2.613	347.2	68.8
1968	679.4	2.590	1759.7	50.7	350.2	3.197	1119.7	44.3	130.9	2.413	315.9	55.7
1969	747.7	3.360	2512.5	108.4	350.0	3.463	1212.3	117.6	132.1	2.768	365.	89.4
1970	738.5	3.186	2352.5	156.3	345.0	3.577	1234.0	141.1	129.9	2.715	352.7	70.8

TABLE A.3 RATIO OF MARKETINGS OF RICE TO TOTAL PRODUCTION, BY MONTHS, KOREA

Crop Year	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov-Apr	May-Oct	Crop Year
							In Narrow Sense (Percent)[1]								
1954-55	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
55-56	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
56-57	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
57-58	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
58-59	7.8	13.1	5.4	3.4	3.4	2.4	2.0	2.2	1.4	1.3	2.4	4.6	35.5	13.9	49.4
59-60	10.5	7.6	3.9	2.5	3.5	3.0	2.2	2.5	1.4	1.1	2.1	4.0	31.0	13.3	44.3
60-61	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
61-62	9.15	10.35	4.65	2.95	3.45	2.70	2.10	2.35	1.40	1.20	2.25	4.30	33.25	13.6	46.85
62-63	9.1	10.3	4.6	3.6	2.9	1.7	1.3	0.7	0.5	1.2	1.1	2.4	32.2	7.2	39.4
63-64	5.6	12.6	4.2	2.3	2.2	1.7	1.5	0.9	0.9	0.6	1.3	4.7	28.6	9.8	38.5
64-65	7.5	11.1	5.7	3.6	3.2	2.9	2.7	1.8	1.7	1.5	1.3	3.0	34.0	12.0	46.0
65-66	8.8	16.1	4.2	3.2	3.1	3.3	2.8	1.6	1.4	1.5	0.9	2.9	38.7	11.1	49.8
66-67	7.51	11.82	5.27	3.94	4.40	3.99	2.51	1.82	2.36	1.67	2.25	4.36	36.93	14.97	51.9
67-68	9.51	11.23	6.02	4.18	4.30	2.89	2.39	1.84	1.03	1.08	1.82	3.92	38.22	12.08	50.3
68-69	5.70	10.42	4.08	3.78	3.69	2.45	3.46	2.81	1.77	1.67	1.97	3.81	30.09	15.51	45.6
69-70	6.75	10.63	5.14	3.22	3.36	3.06	2.81	2.23	2.11	1.85	3.19	4.00	32.66	16.19	48.85
							In Broad Sense (Percent)[1]								
1966	10.74	13.92	8.79	5.84	5.71	5.22	3.07	2.26	2.55	2.05	2.57	5.71	50.22	18.21	68.42
1967	14.31	17.79	8.47	6.76	5.41	3.57	3.30	2.55	1.44	1.54	1.98	5.24	56.31	16.05	72.36
1968	9.10	16.98	8.40	5.87	5.71	3.36	5.39	4.41	2.48	2.13	2.64	5.22	49.42	22.27	71.69
1969	11.13	18.41	8.20	4.56	6.25	3.80	3.66	3.40	2.56	2.70	3.89	5.25	52.35	21.45	73.80

[1] Narrow sense means to include only cash sales and in kind payments such as taxes and charges and milling charges.
Broad sense means to include narrow sense's three items plus wage payment in kind, subsidy and donation, and rent.

Data for 1959-60 and 1963-66 were collected by National Agriculture Cooperative Federation.
Data for 1967-71 were computed by MAF based on Farm Household Economy Survey data.
Data for 1954-58 and 1961~62 were estimated figures.

TABLE A. 4 MONTHLY AVERAGE PRICE RECEIVED BY FARMER FOR RICE, AND WEIGHTED AVERAGE PRICES FOR NOVEMBER-APRIL, MAY-OCTOBER, AND NOVEMBER-OCTOBER

op Year ginning	Average Price Received by Farmer[1]														
	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov-Apr[2]	May-Oct[2]	Nov-Oct[2]
1954-55	977[3]	719[3]	606	622	591	611	809	1050	1099	1200	1320	1020	743.2	1066.3	837.0
55-56	789	815	681	917	910	1090	1447	1669	1728	1810	1843	1509	858.3	1631.4	1082.7
57	1444	1537	1552	1509	1595	1819	1790	1890	1837	1820	1593	1335	1555.5	1638.3	1539.8
58	1186	1167	1187	1220	1209	1307	1424	1446	1458	1420	1482	1344	1196.0	1415.3	1263.5
59	1124	1090	1014	1028	987	1030	1197	1255	1222	1256	1251	1014	1066.1	1163.0	1092.7
60	955	948	967	1065	1173	1256	1292	1437	1556	1629	1470	1374	1017.4	1427.7	1140.6
61	1206	1307	1507	1630	1648	1662	1799	1692	1743	1724	1671	1598	1400.0	1683.4	1482.3
62	1448	1287	1377	1514	1558	1661	1754	1807	1859	1877	1868	1872	1422.5	1841.0	1544.0
63	1767	1792	1822	1933	1994	2193	2346	2804	4117	4028	3675	2890	1850.0	3178.2	2092.7
64	2513	2575	2817	3297	3498	3608	4240	4114	3704	3556	3276	2995	2788.9	3420.7	2951.3
65	2916	3039	3141	3053	2913	3137	3196	3427	3487	3461	3433	3336	3027.5	3365.7	3115.7
66	3013	2922	2995	3167	3104	3211	3382	3461	3468	3793	4186	3577	3010.1	3575.9	3136.2
67	3123	3157	3141	3236	3285	3833	4007	4115	4120	4115	4017	3765	3244.5	3981.0	3457.0
68	3583	3546	3768	4000	4005	4066	4337	4421	4530	4558	4547	4879	3722.4	4593.5	3931.6
69	4313	4751	5246	5293	5056	5073	5269	5641	5766	5790	5798	5699	4966.3	5615.2	5187.0
70	5183	5409	5471	5565	5549	5650	5772	5903	6072	6225	6404	6286	5426.6	6132.4	5660.5
71	6474	6640	6675	6764	6716	6920	7400						6650.0		
72															

First grade, pricing area of origin. All cities for 1955-1958, polished grade B or first grade for 1959-1971.

Monthly average prices were weighted by the ratio of marketings to total production.

The prices are estimated by wholesale prices in Seoul, the difference between Seoul and all cities in corresponding figures.

TABLE A.5 SELECTED ANNUAL DATA ON BARLEY, KOREA

Year	Planted Area 1000 Hectare	Yield MT/ha	Production 1000 MT	Average Price Received by Farmers In June-September: Common W/kg	Naked W/kg	Weighted Average W/kg	Deflated Weighted Average W/kg	Gross Returns Per Hectare Based on June-Sept. Prices: W/ha	Deflated 2/ W/ha	Gross Per ha from Barley ÷ Gross per ha from Wheat	Production Cost W/ha: Total – by Product Value	Total – Land & Capital Service by Product Value	Net over Total Cost – Land & Capital Service – by Product Value W/ha
Regression Code	ABL	YBL	QBL				PBL		RBL				
1955	760	1.370	1041			7.3 3/	23.9	10001	32780	1.07			
1956	796	1.372	1092			10.6 3/	28.2	14543	38678	1.04			
1957	821	1.110	911			13.3 3/	28.7	14763	31886	1.23			
1958	781	1.515	1183			8.6 3/	19.3	13029	29213	1.16			
1959	787	1.727	1359	7.2	6.4	6.9	14.4	11916	24877	0.97			
1960	799	1.715	1370	10.3	10.2	10.3	20.0	17665	34368	1.20			
1961	810	1.825	1478	12.7	11.5	12.2	22.0	22265	40117	1.17			
1962	838	1.646	1379	16.4	13.9	15.3	24.9	25184	41016	1.06			
1963	895	1.026	918	34.0	28.7	32.1	47.1	32935	48363	1.07	32090	22140	10795
1964	942	1.607	1514	32.8	27.2	30.5	35.3	49014	56664	0.98	43240	29030	19984
1965	1031	1.753	1807	25.8	19.5	22.8	22.8	39968	39968	1.02	48150	33550	6418
1966	969	2.083	2018	23.0	17.2	20.0	17.8	41660	37130	0.97	49460	34860	6800
1967	979	1.957	1916	28.1	23.0	25.5	20.1	49904	39294	1.08	52150	34120	15784
1968	986	2.114	2084	31.5	26.1	28.3	18.6	59826	39307	1.12	57920	38040	21786
1969	949	2.177	2066	36.0	31.9	33.7	20.1	73365	43765	1.36	68930	45390	27975
1970	911	2.167	1974	42.2	39.0	40.3	20.9	87330	45225	1.62			

1/ Weights based on production of common and naked barley.

2/ Deflated by index of prices paid by farmer, 1965 = 100.

3/ Estimated

TABLE A.6 SELECTED ANNUAL DATA ON BARLEY, KOREA

Year	PROVINCES IN DOUBLE PADDY CROPPING REGION			PROVINCES IN SINGLE PADDY CROPPING REGION			PROVINCES IN UPLAND CROPPING REGION		
	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT
1955	519.5	1.446	751.1	147.4	1.286	189.5	92.5	1.084	100.3
1956	536.9	1.414	759.4	155.6	1.339	208.4	103.9	1.190	123.6
1957	542.8	1.278	693.6	166.6	.906	150.9	111.9	.947	106.0
1958	531.7	1.569	833.5	150.4	1.521	228.8	99.0	1.217	120.5
1959	536.4	1.792	961.4	151.0	1.660	250.6	99.0	1.481	146.6
1960	545.4	1.774	967.7	153.8	1.640	252.3	100.1	1.501	150.3
1961	555.7	1.872	1040.0	153.7	1.774	272.7	99.5	1.665	165.7
1962	579.4	1.744	1010.5	157.8	1.461	230.5	101.1	1.358	137.3
1963	626.0	.912	571.1	166.0	1.322	219.4	103.0	1.240	127.7
1964	672.4	1.663	1118.5	165.6	1.583	262.2	103.6	1.292	133.9
1965	731.8	1.750	1280.3	180.4	1.080	194.8	119.1	1.275	151.9
1966	685.3	2.163	1482.0	168.2	2.021	340.0	115.9	1.691	196.0
1967	717.2	1.994	1429.9	152.8	1.901	290.4	108.4	1.804	195.6
1968	737.4	2.240	1652.0	144.9	1.830	265.2	103.6	1.607	166.5
1969	719.1	2.252	1619.7	135.1	2.078	280.8	95.2	1.742	165.8
1970	701.4	2.267	1590.2	123.2	1.821	224.3	87.5	1.822	159.4

TABLE A.7 SELECTED ANNUAL DATA ON WHEAT, KOREA

Year	Planted Area 1000 Hectare	Yield MT/ha	Production 1000 MT	Average Price Received by Farmers in June-Sept. W/kg	Average Price Received by Farmers in June-Sept. Deflated[1/] W/kg	Gross Returns Per Hectare Based on June-Sept. Prices W/ha	Gross Returns Per Hectare Based on June-Sept. Prices Deflated W/ha	Production Cost: Total-by Product Value	Production Cost: Total-Land & Capital Service - by Product Value W/ha	Net over Total Cost - Land & Capital Service-by Product Value W/ha
Regression Code	AWH	YWH	QWH		PWH		RWH			
1955	122	1.64	200	5.7	18.7	9350	30700			
1956	124	1.75	218	8.0	21.3	14000	37200			
1957	145	1.50	218	8.0	17.3	12000	25900			
1958	128	1.75	223	6.4	14.3	11200	25100			
1959	126	2.11	267	5.8	12.1	12240	25600			
1960	125	2.07	258	7.1	13.8	14700	28600			
1961	125	2.24	280	8.5	15.3	19040	34300			
1962	134	2.00	268	11.9-	19.4	23800	38800			
1963	138	1.65	228	18.7	27.5	30860	45300	27660	18790	12070
1964	147	2.10	309	23.7	27.4	49770	57500	37960	26110	2[illegible]0
1965	153	1.96	300	20.0	20.0	39200	39200	44230	30230	8970
1966	154	2.05	315	20.9	18.6	42850	38200	47630	32580	10270
1967	153	2.03	310	22.8	18.0	46280	36400	51470	34890	11390
1968	159	2.17	345	24.5	16.1	53170	34900	58720	39120	14050
1969	154	2.37	366	22.7	13.5	53800	32100	70400	47130	6670
1970	159	2.24	357	24.1	12.5	53980	28000			

[1/] Deflated by the index of prices paid by farmers, 1965 = 100.

TABLE A.8 SELECTED ANNUAL DATA ON WHEAT, KOREA

Year	PROVINCES IN DOUBLE PADDY CROPPING REGION			PROVINCES IN SINGLE PADDY CROPPING REGION			PROVINCES IN UPLAND CROPPING REGION		
	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT
1955	72.1	1.752	126.3	27.5	1.738	47.8	22.5	1.187	26.7
1956	70.1	1.757	123.2	30.1	1.774	53.4	24.2	1.715	41.5
1957	88.1	1.554	136.9	29.4	1.459	42.9	27.6	1.384	38.2
1958	72.9	1.835	133.8	29.1	1.866	54.3	25.8	1.353	34.9
1959	73.9	2.198	162.4	29.0	2.079	60.3	23.6	1.864	44.0
1960	73.1	2.145	156.8	29.3	2.119	62.1	22.3	1.771	39.5
1961	73.2	2.332	170.7	29.0	2.166	62.8	22.8	2.031	46.3
1962	81.5	2.177	177.4	29.5	1.932	57.0	23.1	1.463	33.8
1963	84.8	1.438	121.9	30.7	1.625	49.9	22.6	2.474	55.9
1964	93.0	2.126	197.7	29.7	2.246	66.7	24.6	1.833	45.1
1965	93.0	2.376	221.0	31.3	1.345	42.1	28.4	1.296	36.8
1966	88.2	2.070	182.3	33.7	2.151	72.5	32.3	1.873	60.5
1967	92.8	1.968	178.7	33.0	2.115	69.8	29.0	2.114	61.3
1968	99.3	2.281	226.5	31.1	2.152	66.7	28.5	1.813	51.6
1969	97.4	2.368	230.6	30.1	2.511	75.2	26.7	2.239	59.8
1970	104.9	2.287	239.9	29.4	2.081	61.2	24.8	2.241	55.6

TABLE A.9 SELECTED ANNUAL DATA ON BARLEY, WHEAT AND RYE, KOREA

Year	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Average Farm Price Of Barley and Wheat, June-Sept. Weighted by Production W/kg	Deflated W/kg	Deflated Gross Return Per Hectare W/ha
Regression Code	ABW	YBW	QBW		PBW	RBW
1955	916	1.39	1273	7.0	23.0	31970
1956	957	1.41	1347	10.2	27.1	38211
1957	1004	1.20	1200	12.3	26.6	31920
1958	943	1.53	1441	8.3	18.6	28458
1959	959	1.76	1666	6.7	14.0	24640
1960	959	1.74	1668	10.4	20.2	35148
1961	970	1.86	1801	11.6	20.9	38874
1962	1012	1.67	1688	14.7	23.9	39913
1963	1070	1.10	1181	29.4	43.2	47520
1964	1119	1.66	1859	29.3	33.9	56274
1965	1210	1.76	2136	22.4	22.4	39424
1966	1148	2.07	2375	20.1	17.9	37053
1967	1151	1.96	2253	25.1	19.8	28808
1968	1161	2.11	2453	27.8	18.3	38613
1969	1120	2.20	2459	32.6	19.4	42680
1970	1084	2.12	2352	37.9	19.6	41552

1/ Deflated by the index of prices paid by farmers, 1965 = 100

TABLE A.10 SELECTED ANNUAL DATA ON OTHER CEREALS (PRIMARILY CORN AND MILLET), KOREA

Year	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Price Received By Farmers For Millet W/100 l	Price Received By Farmers For Corn W/100 l	Average Price Of Millet and Corn Weighted by Production W/kg	Average Price Of Millet and Corn Weighted by Production Deflated 1/ W/kg	Gross Return Per Hectare W/ha	Gross Return Per Hectare Deflated 1/ W/ha
Regression Code	AOC	YOC	QOC				POC		ROC
1955	221	.414	91.5						
1956	217	.375	81.4						
1957	214	.382	81.8						
1958	221	.491	108.5						
1959	217	.379	86.1	655	451	6.9	14.4	2615	5459
1960	207	.390	80.7	857	619	9.3	18.1	3627	7056
1961	205	.470	96.4	1174	754	12.1	21.8	5687	10247
1962	202	.490	99.0	1288	820	13.1	21.3	6419	10454
1963	205	.526	107.8	2161	1277	21.8	32.0	11466	16837
1964	219	.574	125.6	2845	2095	31.1	36.0	17851	20637
1965	216	.558	120.5	2128	1456	22.2	22.2	12388	12388
1966	171	.626	107.1	2226	1769	25.6	22.8	16026	14283
1967	162	.701	113.5	2575	1898	27.4	21.6	19207	15124
1968	200	.809	161.7	2636	2050	29.2	19.2	23623	15521
1969	144	.950	136.8	2946	1974	30.3	18.1	28785	17165
1970	124	1.001	124.1	3401	2121	33.5	17.3	33533	17272

1/ Deflated by the index of prices paid by farmers, 1965 = 100

TABLE A.11 SELECTED ANNUAL DATA ON PULSES, KOREA

Year	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Wholesale Prices On Soybeans, 1st Grade Pricing Area of Origin W/100 l	Index of Prices Received by Farmers for Pulses 1965 = 100	Deflated Farm Price of Pulses[1/] Index 1965=100	Deflated Farm Price of Pulses[1/] Price Per kg based on 1965=100 W/kg	Deflated Gross Returns Per Hectare[1/] Pulses W/ha	Deflated Gross Returns Per Hectare[1/] Other Cereals W/ha	Pulses Other Cereals W/ha	Index Of Deflated Gross Return per ha on pulses 1965=100
Regression Code	APL	YPL	QPL			PPL					RPL
1955	314	.540	168	623	18.6[2/]	61.0	25.89	13978			58.8
1956	312	.550	173	737	22.0[2/]	58.5	24.83	13669			57.5
1957	321	.540	173	892	26.7[2/]	57.7	24.49	13716			56.6
1958	315	.560	175	825	24.7	55.4	23.51	13170			55.4
1959	316	.500	158	946	28.3	59.1	24.66	14049	5459	8590	52.8
1960	321	.470	150	1171	35.9	69.8	29.63	16593	7056	9537	58.6
1961	341	.560	190	1181	35.6	64.1	27.21	15238	10247	4991	64.2
1962	340	.530	181	1259	37.7	61.4	26.06	14596	10454	4142	58.1
1963	339	.540	182	2083	61.4	90.2	38.29	21442	16837	4605	86.9
1964	336	.560	191	3180	93.3	107.9	45.80	25650	20637	5013	107.9
1965	368	.560	203	3342	100.0	100.0	42.45	23772	12388	11384	100.0
1966	345	.570	195	3793	109.8	97.9	41.56	23273	14238	8990	99.6
1967	380	.620	235	4964	142.0	111.8	47.46	26577	15124	11453	123.8
1968	384	.750	288	3292	111.3	73.1	31.03	17377	15521	1856	97.9
1969	378	.720	273	3878	116.9	69.7	29.59	16560	17165	-605	89.6
1970	368	.750	277	5794	183.1	94.8	40.24	22536	17272	5264	127.0

[1/] Deflated by the index of prices paid by farmers, 1965=100

[2/] Based on soybean prices

TABLE A.12 SELECTED ANNUAL DATA ON POTATOES, KOREA

Year	Planted Area 1000 ha	Yield In Grain Equivalent MT/ha	Production In Grain Equivalent 1000 MT	Index of Farm Prices On Potato,		Index of Gross Return Per Hectare	
				1965=100	Deflated[1/] 1965=100	1965=100	Deflated[1/] 1965=100
Regression Code	APT	YPT	QPT		PPT		RPT
1955	92						
1956	95	2.85	271				
1957	105	2.75	278				
1958	98	3.12	304				
1959	100	2.98	299	38.8	81.0	25.5	49.7
1960	108	3.02	326	45.3	88.1	30.2	54.7
1961	110	3.48	383	47.9	86.3	36.5	61.8
1962	125	3.5-	438	57.4	93.5	42.9	67.3
1963	138	3.73	514	91.1	133.8	71.2	102.5
1964	181	5.17	936	127.5	147.4	136.0	156.4
1965	214	4.87	1046	100.0	100.0	100.0	100.0
1966	210	4.63	972	107.4	95.7	103.5	91.0
1967	196	3.21	631	123.4	97.2	84.1	64.0
1968	198	3.83	759	131.1	86.1	105.7	67.7
1969	193	4.03	778	141.7	84.5	119.7	70.1
1970	182	4.31	783	162.8	84.3	147.0	74.6

1/ Deflated by the index of price paid by farmer, 1965=100.

TABLE A.13 SELECTED ANNUAL DATA ON VEGETABLES, KOREA

Year	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Index of Farm Prices On : Vegetables		Index of Gross Return Per Hectare	
				1965=100	Deflated[1/] 1965=100	1965=100	Deflated[1/] 1965=100
Regression Code	AVG	YVG	QVG		PVG		RVG
1955	108	10.90	1166				
1956	111	8.64	962				
1957	117	10.47	1227				
1958	113	9.86	1112				
1959	110	9.18	1010	32.3	67.4	28.3	59.1
1960	118	9.25	1088	47.5	92.4	42.0	81.7
1961	172	7.18	1235	39.6	71.4	27.2	49.0
1962	124	10.49	1300	43.2	70.4	43.3	70.5
1963	121	9.83	1187	86.9	127.6	81.7	120.0
1964	139	10.32	1436	83.1	96.1	82.0	94.8
1965	151	10.46	1576	100.0	100.0	100.0	100.0
1966	154	11.14	1717	127.6	113.7	135.9	121.1
1967	177	10.55	1869	108.0	85.0	108.9	85.7
1968	193	11.16	2150	109.9	72.2	117.3	77.1
1969	226	10.73	2427	123.2	73.5	126.4	75.4
1970				250.1			

1/ Deflated by the index of prices paid by farmers, 1965=100

TABLE A.14 SELECTED ANNUAL DATA ON FRUIT, KOREA

Year	Planted Area 1000 ha	Yield MT/ha	Production 1000 MT	Index of Farm Prices On Fruit 1965=100	Index of Farm Prices On Fruit Deflated[1/] 1965=100	Index of Gross Return Per Hectare 1965=100	Index of Gross Return Per Hectare Deflated[1/] 1965=100
Progression Code	AFR	YFR	QFR		PFR		RFR
1955	19.6	5.97	117				
1956	20.3	5.76	117				
1957	20.5	6.22	127				
1958	22.5	6.75	152				
1959	23.3	7.16	117	45.7	95.4	45.2	94.4
1960	22.5	7.41	166	47.5	92.4	48.7	94.8
1961	23.1	6.48	150	54.3	97.8	48.7	87.7
1962	23.2	8.43	195	54.6	88.9	63.6	103.6
1963	23.7	7.50	178	56.0	96.9	68.5	100.6
1964	28.6	8.00	229	102.0	117.9	112.9	130.5
1965	42.9	7.23	310	100.0	100.0	100.0	100.0
1966	45.2	7.33	331	102.2	91.1	103.6	92.3
1967	48.1	7.46	359	116.2	91.5	119.9	94.4
1968	51.2	7.66	392	149.9	98.5	158.8	104.3
1969	55.7	7.48	417	193.0	115.1	199.7	119.1
1970				216.3			

1/ Deflated by the index of prices paid by farmer, 1965=100.

TABLE A.15 SELECTED ANNUAL DATA ON MULBERRY AND COCOON, KOREA

Year	Planted Area of Mulberry	Yield of Cocoon	Production of Cocoon	Weighted Average Farm Price[1] of Cocoon		Gross Return Per ha		Central and Local Government Expense On Sericulture (including subsidy)[3]	
	1000 ha	kg/ha	1000 MT	W/kg	Deflated[2] W/kg	Actural W/ha	Deflated[2] W/ha	Actual Mil W	Deflated[2] Mil W
Regression Code	ACN	YCN	QCN		PCN		REN		GCN
1955	32.4	202	6.536	38	125	7676	25167		230
1956	34.5	172	5.934	41	109	7052	18755		230
1957	36.2	159	5.756	46	99	7314	15797		230
1958	36.7	154	5.670	46	103	7084	15883		230
1959	36.1	152	5.477	47	98	7144	14914		200
1960	20.4	225	4.599	67	130	15075	29329		200
1961	23.4	209	4.896	77	139	16093	28996		200
1962	27.3	202	5.513	103	168	20806	33886	177	288
1963	30.9	199	6.142	111	163	22089	32436	170	250
1964	42.3	138	5.842	180	208	24840	28717	464	536
1965	50.5	154	7.768	217	217	33418	33418	558	558
1966	61.7	156	9.601	270	241	42120	37540	808	720
1967	68.5	159	10.903	280	220	44520	35055	437	344
1968	94.4	176	16.616	320	210	56320	37004	1482	974
1969	99.3	209	20.748	346	206	72314	43121	1480	882
1970	85.0	252	21.409	366	190	92232	47764	936	485

[1] Weighted by production of spring and fall cocoons.
[2] Deflated by index of price paid by farmer, 1965=100
[3] Source = Sericulture Manual
[4] Estimate

TABLE A.16 SELECTED ANNUAL DATA ON TOBACCO, KOREA

Year	Planted Area 1000 Hectare	Yield MT/ha	Production 1000 MT	Price of Tobacco Received by Farmer W/kg	Price of Tobacco Received by Farmer Deflated W/kg	Gross Return Per Hectare W/ha	Gross Return Per Hectare Deflated[1/] 1000 W per ha
Regression Code	ATB	YTB	QTB		PTB		RTB
1955							
1956							
1957							
1958							
1959							
1960							
1961	20.2	1.56	31.5	55.6	100.2	86736	156.3
1962	22.5	1.55	35.0	65.0	105.9	100750	164.1
1963	21.9	1.32	29.0	106.1	155.8	140052	205.7
1964	29.4	1.68	49.3	141.2	163.2	237216	274.2
1965	34.4	1.63	56.1	133.0	133.0	216790	216.8
1966	36.7	1.96	72.1	132.9	118.4	260484	232.2
1967	37.6	1.76	66.0	135.9	107.0	239184	188.3
1968	38.7	1.80	69.7	141.6	93.0	254880	167.5
1969	39.1	1.51	59.2	171.3	102.1	258663	154.2
1970	43.0	1.31	56.3	225.5	116.8	295405	153.0

[1/] Deflated by the index of prices received by farmer, 1965=100.

TABLE A.17 SELECTED ANNUAL DATA ON CATTLE, KOREA

Year	Number of Milk Cows 1000 head[1]	Milk Prod. Per Cow[1] kg	Total Fresh Milk Prod. 1000 MT	No. of Beef Cattle[2] 1000 Head	No. of Korean Draft Cattle[2] 1000 head	Total Inspected Cattle Slaughter 1000 head	Beef Production 1000 MT	Index of Cattle Prod. 1964-66=100	Farm Price of Cattle: Female Over 7 Yrs for Meat 1000 W Per Hd	Farm Price of Cattle: Male Over 6 Years for Meat 1000 W Per Hd	Farm Prices of Cattle Retail Weight Equivalent: W/kg	Farm Prices of Cattle Retail Weight Equivalent: Deflated W/kg
Regression Code							QBF					PBF
1955	.33				867		11.0	44.6	8.5[3]		69	226
1956	.40				917		12.5	51.0	9.2[3]		75	199
1957	.55				967		13.3	51.1	11.1[3]		91	197
1958	.64			.57	1000		14.0	68.3	11.4[3]		93	209
1959	.77			.67	1023	188	18.0	64.9	11.9	13.3	97	203
1960	.87			.66	1010	131	12.6	46.6	15.7	17.3	128	249
1961	1.15			.23	1096	137	13.3	54.6	17.6	18.7	144	259
1962	2.40	1083	2.6	.86	1253	174	16.8	67.2	19.0	20.1	155	252
1963	3.50	1286	4.5	.96	1363	218	21.1	78.3	20.0	21.8	163	239
1964	5.20	1365	7.1	.91	1351	330	31.9	120.1	23.4	25.3	191	221
1965	6.61	1619	10.7	.80	1314	283	27.3	93.2	35.2	40.7	287	287
1966	8.47	1724	14.6	1.14	1290	262	29.4	86.6	42.3	48.1	345	307
1967	10.35	1853	19.2	2.13	1243	256	31.9	82.6	51.5	61.6	447	352
1968	13.76	1773	24.4	3.30	1194	213	35.8	72.1	71.0	79.5	580	381
1969	18.82	1886	35.5	3.95	1202	219	33.1	76.0	71.2	85.2	581	346
1970	22.83	2273	51.9	3.02	1271	286	37.3		82.9	98.3		
1971	30.00											

1/ Total includes replacements and bulks.

2/ Inventory on farm as of December 31.

3/ Derived from price of bonless beef, butchers price, all cities.

4/ Deflated by the index of prices paid by farmers, 1965=100.

TABLE A.18 SELECTED ANNUAL DATA ON HOGS, KOREA

Year	No. of Pigs On Farms, Dec. 31	Total Inspected Hog Slaughter	Pork Production	Index Of Hog Production 1964-66=100	Farm Price Of Hogs Per Hd (Approx. 75 kg) W[1]	Farm Price of Hogs Retail Weight Equivalent		Price Of Wheat Bran Paid By Farmers Deflated[2] W/kg	Hog Prices ÷ Price of Wheat Bran	Deflated Cost of Wheat Bran Per kg of Pork[3] W/kg	Deflated Price Of Hogs-cost of Wheat Bran W/kg
						W/kg	Deflated[2] W/kg				
	1000 Hd	1000 Hd	1000 MT								
Regression Code			QPK				PPK				MPK
1955	1262		24.4	70.4	1350	33.75	110.7				
1956	1161		57.8	94.8	1559	38.98	103.7				
1957	1233		50.3	87.2	2081	52.02	112.4				
1958	1324		49.9	92.9	2137	53.45	119.8				
1959	1439		52.4	100.1	2100	52.50	109.6				
1960	1397	84	58.0	105.3	2189	55.00	107.0	10.31	10.4	103.1	3.9
1961	1226	238	60.0	100.1	2508	62.70	113.0	8.83	12.8	88.3	24.7
1962	1672	249	38.0	101.5	3544	88.60	144.3	10.09	14.3	100.9	43.4
1963	1510	265	55.1	119.9	3362	84.05	123.4	10.27	12.0	102.7	20.7
1964	1256	179	62.5	106.0	4886	122.15	141.2	9.83	14.4	98.3	42.9
1965	1332	203	55.9	95.3	7331	183.28	183.3	8.60	21.3	86.0	97.3
1966	1457	395	95.8	98.6	6529	163.22	145.5	13.10	11.1	131.0	14.5
1967	1296	357	72.2	103.7	8909	222.72	175.4	10.55	16.6	105.5	69.9
1968	1396	395	61.8	80.7	12885	322.12	211.6	9.66	21.9	96.6	115.0
1969	1338	637	75.1	86.4	10664	266.60	159.0	9.18	17.3	91.8	67.2
1970	1121	617	79.2		13352	333.80	172.8	7.51	23.0	75.1	97.7

1/ Based on prices of boneless lean pork, butchers price, all cities.

2/ Deflated by the index of prices paid by farmers.

3/ Assumes that 10 kg of wheat bran is required to produce 1 kg of pork at retail.

TABLE A.19 SELECTED ANNUAL DATA ON POULTRYMEAT, KOREA

Year	Poultry-meat Production 1000 MT	Farm Price of Chicken, Hen W/head	Farm Price of Poultry-Meat Retail Weight Equivalent		Price Of Broiler Feed W/kg 2/	Cost of Broiler Feed Per kg of Poultrymeat 3/		Deflated Broiler Price - Cost of Broiler Feed W/kg	Broiler Eggs	
			W/kg	Deflated 1/ W/kg		W/kg	Deflated 1/ W/kg		Put Into Incubators 1000	Hatched 1000
Regression Code	QPM			PPM				MPM		
1955	6.1	75 4/	68.2	223.6						
1956	13.3	85 4/	77.3	205.6						
1957	13.4	100 4/	90.9	196.3						
1958	13.8	110 4/	100.0	224.3						
1959	13.6	112	101.8	212.5						
1960	18.1	114	103.6	201.6	10.85	32.6	63.4	138.2		
1961	18.5	121	110.0	198.2	10.95	32.9	59.3	138.9		
1962	15.7	136	123.6	201.3	13.84	41.5	67.6	133.7		
1963	20.3	154	140.0	205.6	16.69	50.1	73.6	132.0		
1964	18.8	216	196.4	227.1	19.56	58.7	67.9	159.2	2252	1712
1965	14.5	319	290.0	290.0	20.21	60.6	60.6	229.4	704	494
1966	18.7	355	322.7	287.6	30.33	91.0	81.1	206.5	2129	1553
1967	24.0	424	385.5	303.5	30.45	91.4	72.0	231.5	2646	1947
1968	35.8	456	414.5	272.3	32.94	98.8	64.9	207.4	10295	7520
1969	42.2	418	380.0	226.6	36.29	108.9	64.9	161.7	10217	7592
1970		500	454.5	235.4	34.31	102.9	53.3	182.1	24039	17577

1/ Deflated by the index prices paid by farmers 1965=100.

2/ Data for 1960–67 were based on the index of feed prices.

3/ Assumes 3 kg of feed is required per kg of broiler at retail.

4/ Derived from wholesale prices.

TABLE A.20 SELECTED ANNUAL DATA ON EGGS, KOREA

Year	Number Of Chickens on Farms Dec. 31 1000 head	Egg Production 1000 MT	Price of Eggs: W Per 10 eggs	Price of Eggs: W/kg	Price of Eggs: Deflated[1/] W/kg	Price Of Eggs ÷ Index Of Feed Prices W/kg	Price Of Layer Feed[2/] W/kg	Cost of Feed Per kg Of Eggs Produced[3/]: W/kg	Cost of Feed Per kg Of Eggs Produced[3/]: Deflated[1/] W/kg	Deflated Egg Price - Cost of Feed W/kg
Regression Code		QEG			PEG					MEG
1955		16.[illegible]	20.8[4/]	41.6	136.4					
1956		27.3	24.2[4/]	43.4	128.7					
1957		29.2	27.8[4/]	55.6	120.1					
1958	9894	30.2	30.8[4/]	61.6	138.1					
1959	12041	33.7	29.0	58.0	121.1					
1960	12030	41.0	29.0	58.0	112.8	108.0	9.56	40.6	79.0	33.8
1961	11218	40.9	32.0	64.0	115.3	118.1	9.65	41.0	73.9	41.4
1962	13047	42.0	37.0	74.0	120.5	108.0	12.19	51.7	84.2	36.3
1963	11907	48.8	44.0	88.0	129.2	106.5	19.70	62.4	91.6	37.6
1964	10282	47.2	64.0	128.0	148.0	132.2	17.23	73.1	84.5	63.5
1965	11893	42.8	87.0	174.0	174.0	174.0	17.80	75.5	75.5	98.5
1966	14008	64.9	88.0	176.0	156.9	117.3	26.72	113.4	101.1	55.8
1967	17079	67.5	97.0	194.0	152.8	128.7	28.00	118.8	93.5	59.3
1968	25968	79.3	94.0	188.0	123.5	115.3	28.90	122.7	80.6	42.9
1969	22651	121.5	95.0	190.0	113.3	105.8	30.50	129.4	77.2	36.1
1970	23477		121.0	242.0	125.3	142.5	30.22	128.3	66.4	58.9

1/ Deflated by the index of price paid by farmer 1965=100.

2/ Data for 1960 to 1966 were based on the index of feed price.

3/ Derived by mul price of buyer feed by 4.244 the assumed kg of feed required to produce 1 kg of eggs.

4/ Derived from wholesale prices on medium grade all cities.

TABLE A.21 MISCELLANEOUS DATA USED IN THE ANALYSIS OF SUPPLY, KOREA

Year	Seoul Consumer Price Index 1965=100	Index of Prices, Wages, and Charges Paid By Farmers 1965=100	Index of Feed Prices Paid By Farmer 1965=100	Price of Bran Paid by Farmers		
				Wheat W/100 l	Rice W/100 l	Barley W/100 l
1955	30.5	30.5[1]				
1956	37.6	37.6[1]				
1957	46.3	46.3[1]				
1958	44.6	44.6[1]				
1959	46.1	47.9				
1960	48.9	51.4	53.7	190	195	149
1961	52.9	55.5	54.2	178	196	138
1962	56.4	61.4	68.5	222	245	186
1963	68.0	68.1	82.6			
1964	88.1	86.5	96.8	311	354	247
1965	100.0	100.0	100.0	311	380	236
1966	112.1	112.2	150.1	530	518	390
1967	124.2	127.0	150.7	484	541	408
1968	138.0	152.2	163.0	530	584	435
1969	152.0	167.7	179.6	554	630	551
1970	171.3	193.1	169.8	522	592	532
1971		230.2(est)				

[1] Assumed to be the same as Seoul consumer price index.

APPENDIX B

A Note on Marketings of Rice

Since less than half of the rice crop is generally marketed "in the narrow sense," producers' inclination to sell or not to sell is a major consideration in the commercial supply picture. As a hypothesis, two major factors were believed to influence the porportion of the rice crop sold. One was the size of the crop. The larger the crop, the smaller proportion a farmer would need to retain to feed his family. The second variable was the gross margin per hectare. The higher the gross margin, *ceteris parabus*, the less the farmer needed to sell to meet cash expenses for the farm and household. This relationship was suggested by the experience in other less developed countries and by a survey of rice marketing in Korea.[1] The latter study concluded that "Principally the farmers sell their rice to meet family living expenses, particularly for education, and to purchase fertilizer." As the level of farm income increases in the future, however, this negative effect between gross margin and the proportion of the crop sold may disappear.

Data for 1958, 1959, 1960 and 1962-1969 were available on the percent of the rice crop sold "in the narrow sense." An equation was estimated from data for those years as follows:

$$\text{Percent of rice crop sold}_t = 18.09 + \underset{(2.55)}{164.21}\ \text{Production}$$

$$\text{per capita of the farm population}_t - \underset{(-2.72)}{.1166}\ \text{Deflated Gross Margin}_t$$

R^2 = .41 SE. = 3.34

[1] NACF, Joint Marketing Research Group, Survey of Rice Marketing in Korea, February, 1969.

The proportion of the variation in the percent of the crop sold explained by the equation was not very high ($\bar{R}^2$ = .41) but both independent variables were significant and had the expected signs. The two independent variables were positively correlated with a correlation coefficient of .565. The conclusion is that production and gross margin affected the percent sold, but other factors are also apparently important. The data used in the analysis are given in the Table B.1.

Table B.1 Factors Affecting Marketings of Rice "in the Narrow Sense", Korea

Crop Year	Percent Of Crop Marketed[1/]	Production Per Capita Of Farm Population	Deflated Gross Margin[2/]
	%	MT	1000 W/ha
1958	49.4	.224	24.5
1959	44.3	.216	44.5
1960	46.8	.210	60.0
1962	39.4	.197	71.0
1963	38.5	.242	133.3
1964	46.0	.250	109.1
1965	49.8	.222	69.0
1966	51.9	.244	80.5
1967	50.3	.226	72.4
1968	45.6	.205	78.2
1969	48.8	.260	98.6

1/ See Table A.3

2/ See Table A.1

APPENDIX C

Regional Analysis on Rice

An effort was made to examine supply response in different regions of South Korea. The regions were established on the basis of whether they are dominated by a double cropping paddy system, a single cropping paddy system or an upland cropping system. The double paddy region included Jeon-bug, Jeon-nam, Gyeong-Bug, and Gyeong-nam province. The single paddy region included Seoul, Kyeong-gi, and Chung-nam. The upland region included Gang-weon, Chung-bug, and Je-ju province.

Models similar to those applied to the entire country were estimated for each of the three regions. Regional data on area yield and production were calculated. Gross return per hectare for each region were estimated by multiplying the regional yield per hectare by the national average price since regional prices were not available. Also the production cost data used to calculate regional gross margin were national rather than regional. A weather variable was constructed for each region using May and June rainfall in the relevant two or three cities. Due to unavailability of time series data on provincial rice area and production before 1962, the analysis included only the 1960-70 period, with estimated data for 1960 and 1961.

The regional supply models produced reasonably satisfactory results for the single paddy provinces and the upland provinces, but poor results for the double paddy provinces, in terms of statistical properties of the equations. This is not altogether surprising since there may be less flexibility in expanding area of double paddy as compared to single paddy and upland areas.

An element not taken into account in the regional analysis is the effect of urbanization on rice area. Urbanization and the effect of rapid land value increases in the suburban areas would be expected to cause a shift of rice land out of production or to other crops.

To eliminate such effects on paddy land, the area of the five largest cities—Seoul, Pusan, Kwangju, Taigu, and Daijun—and their neighboring counties plus the area of 32 other cities are excluded from this regional analysis. For the convenience of identifying the regional equations, the following regional initials are added to the original code and commodity symbols:

D: Double Paddy Region

U: Upland Region

S: Single Paddy Region

Double Paddy Region

(1) $DARC_t = 540.6428 + \underset{(.35)}{.12558}\ DARC_{t-1} + \underset{(1.22)}{.00046}\ DMRC_{t-1} + \underset{(.00)}{.0015}DW_t$

$\bar{R}^2 = -.14 \qquad SE. = 28.24$

(2) $DYRC_t = 1.5152 + \underset{(.38)}{.01045}\ T + \underset{(2.10)}{.03179}\ PRC_{t-1} + \underset{(2.03)}{.0018}\ DW_t$

$\bar{R}^2 = .39 \qquad SE. = .24$

(3) $DQRC_t = 780.6725 + \underset{(.74)}{17.3363}\ T + \underset{(1.99)}{25.5073}\ PRC_{t-1} + \underset{(1.51)}{1.13067}\ DW_t$

$\bar{R}^2 = .31 \qquad SE. = 204.96$

(4) $\log DQRC_t = 5.0091 + \underset{(.67)}{.0068}\ T + \underset{(2.34)}{.53613}\ \log PRC_{t-1} + \underset{(2.42)}{.12877}\ \log DW_t$

$\bar{R}^2 = .53 \qquad SE. = .0879$

The explanatory power of the area equation (1) is very low with an $\bar{R}^2$ of -.14. The coefficients of the lagged gross margin and the weather variable are quite low; and also their "t" values are not significant at the five percent level, but their coefficients expressed a correct sign.

In the yield equation (2), the "t" value of one year lagged price is significant and also its coefficient carried a correct sign. In spite of the fact that the "t" value of the weather variable is not significant in the area equation (1), it is significant in the equation (2). The $\bar{R}^2$ on (2) is higher than on (1) but still relatively low at .39.

The production equation (4) in logs, was an improvement over the arithmetic form in (3) and resulted in significant coefficients on price and weather. The $\bar{R}^2$ of .53 was not as high as desired.

Of particular interest are estimates of long-run price elasticity of production of the three regions. The elasticity estimation method used is the same as that of the national studies.

Using the area equation (1) with the assumption of the deflated price and gross margin of 1968/70 applying in 1985, the area of the region will decline slightly from 674,100 ha in 1970 to 666,100 ha in 1985. If gross margin increases by 10 percent and the other variables remain constant, the area will continue at about 671,300 hectares.

The long-run elasticity of rice area with respect to gross margin is .078. Since gross returns on rice are about 1.43 times the gross margin, the elasticity on area with respect to price is .11.

Using the assumption of deflated rice price of 1968-70 and the last ten years average rainfall in May and June, the yield per hectare in 1985 is 3.25 MT which is slightly higher than the recent average yield 3.09 MT (3 year average yield per hectare excluding the highest and the lowest yield year in 1966/70).

If the deflated price of 1968/70 is raised by 10 percent and the other variables remain constant, the yield per hectare would reach 3.38 MT in 1985. The elasticity on yield with respect to price is .38 which is noticeably higher than the price elasticity on area.

Combining equations (1) and (2) to make a projection of rice production in 1985 with the deflated price of 1968/70, the production would reach 2,165,000 MT, and if the price rises by 10 percent, the production would reach 2,269,000 MT which is 4.8 percent higher than the original projection.

Consequently, by using equation (1) and (2), the long run elasticity of supply with respect to price is .48.

In production equation (3), if the deflated rice price of 1968/70 were maintained up to 1985, the production would reach 2,360,000 MT. Raising the price by 10 percent and assuming all other factors were constant, rice production of the region would reach 2,461,000 MT.

According to equation (3), the projected production is higher than the projection using equation (1) and (2), however, the elasticity of supply with respect to price (.42) is lower than .48 which was derived from equations (1) and (2).

The logarithmic equation (4) has somewhat more explanatory power than the ordinary equation (3). Using logarithmic equation (4), we can directly read the long run elasticity of supply from the coefficient of the price variable--.54.

In this equation, the projected production with constant prices at 1968/70 levels would be 2,437,000 MT, and if the price were raised by 10 percent, the production would reach 2,565,000 MT. We conclude that the long-run elasticity of supply with respect to price in the double paddy region is somewhere between .42 and .48. This is appreciably higher than the .085 to .212 found for the nation as a whole.

Single Paddy Region

(5) $SARC_t = 80.22405 + .70587\ SARC_{t-1} + .22232\ PRC_{t-1} - .04617\ SW_t$

(9.05) (1.61) (-4.01)

$R^2 = .93$ SE. = 2.24

(6) $SYRC_t = 2.12776 + .07031\ T + .000004\ SMRC_{t-1} + .00299\ SW_t$

$$(3.90) \quad (1.67) \quad (3.72)$$

$\bar{R}^2 = .77$ SE. = .15

(7) $SQRC_t = 503.46414 + 27.7652\ T + 4.25305\ PRC_{t-1} + .65271\ SW_t$

$$(6.16) \quad (1.70) \quad (3.19)$$

$\bar{R}^2 = .85$ SE. = 39.81

(8) $\text{Log}\ SQRC_t = 5.37159 + .02918\ T + .24089\ \text{Log}\ PRC_{t-1} + .08366\ \text{Log}\ SW_t$

$$(7.75) \quad (2.80) \quad (5.18)$$

$\bar{R}^2 = .92$ SE. = .033

The explanatory power of the area equation (5) is markedly high with an $\bar{R}^2$ of .93. The coefficients of the one year lagged acreage and price show the correct sign though the coefficient on the price variable is not significant. The negative coefficient on the weather variable is probably due to developed paddy land with well equipped irrigation facilities along the basins of the Han and Kum rivers.

Using the deflated price of 1968/70, the area is projected to 286,400 hectares in 1985. With a 10 percent price increase the area will reach 289,400 hectares. The long run elasticity of area with respect to price is .10.

In the yield equation (6), the explanatory power of $\bar{R}^2$ is also significantly high at .77. The coefficients of the independent variables carry the correct sign. The "t" values of time series and weather variables are significant at 5 percent level; the "t" value of the price (margin) variable is not significant.

Using the assumption of the continuation of the gross margin realized in 1968/70, the projected yield in 1985 will be 4.63 MT. With a 10 percent increment of gross margin, the projected yield using equation (6) will reach 4.67 MT. The long run elasticity on yield with respect

Combining equations (5) and (6), the projected production with the constant price in 1968/70 would be 1,326,000 MT and with a raising by 10 percent of the price, the production would be 1,357,000 MT.

With respect to the production equation (7), the explanatory power of $\bar{R}^2$ is fairly high at .85. All the coefficients carry correct signs and those of time series and weather variables are significant.

Projected production in 1985 using the average deflated price of rice in 1968/70 will be 1,431,000 MT which is 37 percent higher than 1969's actual production. With a 10 percent increment of rice price, projected production will reach 1,448,200 MT, only slightly different from the case of no price increment. Using equation (7), the long run elasticity of supply with respect to price is .12.

The logarithmic equation (8) fit the data quite well with an $\bar{R}^2$ of .92. The coefficients on all of the independent variables were significant with the correct sign.

The projected production in 1985 using the average deflated price of 1968/70 is 1,612,000 MT which is almost 22 percent higher than the original projection using equations (5) and (6). With a 10 percent price increment, the production would be 1,649,000 MT. In the analysis of the region, the projected production is on the high side due to the strong time trend effect, and probably due to only the last ten years of data being used. At the moment, we are not sure the strong time trend factor of the last decade will continue to 1985. Equation (8) indicates a long run price elasticity of supply of .24

The projected production from the equation for the single paddy region may be on the high side compared with what we expected, and the long run elasticity of supply lies somewhere between .23 and .24 which is somewhat larger compared with that of the upland region.

Upland Region

(9) $UARC_t = 9.03386 + .8597\ UARC_{t-1} + .14527\ PRC_{t-1} + .03861\ UW_t$
$\qquad\qquad\qquad\qquad (10.36) \qquad\qquad (1.05) \qquad\qquad (2.19)$

$\bar{R}^2 = .94 \qquad SE. = 1.83$

(10) $UYRC_t = 1.8293 + .2315\ UYRC_{t-1} - .0042\ PRC_{t-1} + .0044\ UW_t$
$\qquad\qquad\qquad\qquad (.79) \qquad\qquad (-.34) \qquad\qquad (2.65)$

$\bar{R}^2 = .45 \qquad SE. = .15$

(11) $UQRC_t = 231.70019 + 4.64952\ T + .00027\ UMRC_{t-1} + .49442\ UW_t.$
$\qquad\qquad\qquad\qquad (3.07) \qquad\qquad (1.08) \qquad\qquad (4.39)$

$\bar{R}^2 = .76 \qquad SE. = 13.53$

(12) $\text{Log } UQRC_t = 4.64546 + .010138\ T + .13750\ \text{Log } PRC_{t-1} + .128598\ \text{Log } UW_t$
$\qquad\qquad\qquad\qquad (2.42) \qquad\qquad (1.26) \qquad\qquad (4.68)$

$\bar{R}^2 = .83 \qquad SE. = .036$

The explanatory power of the area equation (9) is markedly high with an $\bar{R}^2$ of .94. The coefficients of price and weather variables show the correct sign although the "t" value of price is not significant.

Under the assumption of using deflated average price of 1968/70, the projected area in 1985 will be 130,000 hectares. If the deflated price were raised 10 percent, the area in 1985 will be 134,000 hectares, 3 percent higher than before the price change.

The long run elasticity of area with respect to price is .31. Someone might question where the area will expand. The fairly large elasticity of area is probably due to the greater flexibility of land use in upland areas as compared with paddy land. Paddy land probably would not increase very much if at all.

Usually, upland rice is not commercialized and the objective of upland rice cultivation is mainly for family consumption. The farmer whose self-produced rice can not meet his own family use until the next rice harvesting season has to buy rice at market in early spring or later summer of the year. If he has to pay a high price, the farmer will expand upland rice acreage under the expectation of a substantial amount of expenditure on rice. Alternatively, if the price is low, he may not have the incentive to grow quite as much of his own rice. Of course, some upland farmers do sell some rice each year and would respond to price changes in the market.

In addition to the above facts, the farmers' diets in the upland region include a variety of miscellaneous grains, potatoes, and upland rice as staple food grains compared with the rice bowl area such as the double paddy and single paddy regions. They are willing to shift between crops as relative prices change. However, further investigations are needed to find out what is the cause of the .3 supply elasticity on area in the region.

In yield equation (10), the explanatory power is relatively low with an $\bar{R}^2$ of .45. The "t" values of both one year lagged yield and price variables are not significant, and also the coefficient of the price variable is showing a negative sign. The "t" value of weather is significant at the five percent level.

If the price of rice were the same as the deflated price of 1968/70, the yield per hectare of the region in 1985 would be 2.68 MT, and if the price were raised by 10 percent, the yield would be 2.66 MT.

Consequently, the long run elasticity on yield with respect to price is -.08. The negative effect on yield seems to be odd; however, this may be explained by the expansion of rice area into marginal sections of upland results in reduced yields.

The projected production using equations (9) and (10), is 348,000 MT under the assumption of the same price as the years of 1968/70; and if the price were raised by 10 percent, the production would be 356,000 MT. Consequently, the elasticity of supply with respect to price is .23.

In equation (11), $\bar{R}^2$ is fairly high at .76. Both the "t" values of the time series and the weather variable are significant at the 5 percent level. However, the "t" value of the coefficient on gross margin is not significant. Using the assumption of deflated rice price of 1968/70, the production will be 412,000 MT, and if the price were raised by 10 percent, the production will be 415,200 MT. Both projections are substantially above the 1970 level of 335,700 MT. The long run elasticity of supply with respect to price is therefore .07.

With logarithmic production equation (12), the explanatory power of $\bar{R}^2$ is reasonably high at .83, and also the coefficients of time series, price and weather variables show the correct signs. Except for the "t" value of price, the coefficients are significant at the 5 percent level.

The elasticity of supply with respect to price is directly readable from the coefficient of price at .14. Consequently, the elasticity of supply with respect to price is somewhere between .07 and .23.

Conclusions

To examine internal consistency between the national and the regional analyses, the national elasticities were derived from those of each region by weighting area and production in each region.

Comparing national and regional analyses of a long run elasticity for price as it affects area, .13 was derived from the regional analysis which is consistent with the .16 estimated in the national analysis.

In case of yield responses with respect to price, the price elasticity as it affects yield of the regional result is .16 which lies higher than .06 of the national analysis results.

The reasons for the substantial difference in price elasticity as it affects yield between the regional and the national analysis seems partially due to the exclusion of 32 cities and the neighboring counties in the regional analysis. In any case, the price elasticity as it affects area would be expected to differ between a purely agricultural region and an urban region. The price elasticity in a predominately agricultural region probably is higher than that in the city and its suburban area. One difference noted is that yields in urban areas have declined relative to other areas.1/

Concerning the long run elasticity of supply with respect to price, .29 was computed from the regional analysis with 1960/70 data, this being somewhat higher than the .085 to .212 range calculated from the national analysis using 1955/70 data. Again, the exclusion of urban areas in the regional analysis may account for this difference. As far as price elasticities are concerned, the price responses on acreage, yield and production are fairly rigid using both 1955/70 and 1960/70 time series data.

Considering the difference in time series between the national and the regional analysis and urban and industrial effects on rice area and production,

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1/See the Appendix D, "Effect of Urbanization on Rice Yields."

the results of the national and regional analysis are fairly consistent As demonstrated in Table C.2, the percentage error in predicted versus actual production in the regional models was somewhat less than for the national model; 3.37 percent relative to 4.94 percent.

The following table summarizes the major findings generated from the regional analysis.

Table C.1

THE MAJOR RESULTS OF THE REGIONAL ANALYSIS ON RICE

By Region	By Equation	Price Elasticity As It Affects	Actual Figure in 1970	Projection in 1985: With De-flated Price of 1968/70	Projection in 1985: With 10% Price Increases
	(1)Acreage	.11	674.1(Thou.ha)	666.1	671.3
Double-	(2)Yield	.38	3.18(MT/ha)	3.25	3.38
Paddy	(1)&(2)Production	.48	2,145(Thou.MT)	2,165	2,269
Region	(3)Production	.42	2,145(Thou.MT)	2,360	2,461
	(4)Production	.54	2,145(Thou.MT)	2,437	2,565
	(5)Acreage	.10	285.3(Thou.ha)	286	289
Single-	(6)Yield	.13	3,66(MT/ha)	4.63	4.67
Paddy	(5)&(6)Production	.23	1,046(Thou.MT)	1,326	1,357
Region	(7)Production	.12	1,046(Thou.MT)	1,431	1,448
	(8)Production	.24	1,046(Thou.MT)	1,612	1,649
	(9)Acreage	.31	123.4(Thou.ha)	130	134
Up-	(10)Yield	-.08	2.72(MT/ha)	2.68	2.66
Land	(9)&(10)Production	.23	353.7(Thou.MT)	348	356
Region	(11)Production	.07	335.7(Thou.MT)	412	415
	(12)Production	.14	335.7(Thou.MT)	399	404

Remarks: For consistency with the national results, minor adjustments are required due to the exclusion of 32 cities' and the five largest cities' neighboring counties in this analysis.

Table C.2

COMPARISON OF PRODUCTION FROM REGIONAL EQUATIONS
WITH EQUATION 4 IN THE NATIONAL MODEL

	Predicted Production				Actual Production					Equation 4 of National Model		
	Double Paddy Region (Equation C-4)	Single Paddy Region (Equation C-8)	Up-Land Region (Equation C-12)	Total (A)	Double Paddy Region	Single Paddy Region	Up Land Region	Total (B)	(B-A)	Predicted Production (C)	Actual (D)	(D-C)
	----------	----------	----------	----------	Thous. MT	----------	----------	----------	----------	----------	----------	----------
1961	1831	775	304	2910	1921	804	312	3037	127	3319	3463	144
62	1677	740	265	2682	1633	714	265	2612	- 70	3179	3015	-164
63	2275	895	335	3505	2126	880	331	3337	-168	3932	3758	-174
64	2302	910	358	3570	2231	926	362	3519	- 51	3752	3954	202
65	1975	799	310	3084	2010	779	302	3091	7	3458	3501	43
66	1986	883	340	3209	2261	886	327	3474	265	3746	3919	173
67	1942	915	315	3172	1930	914	331	3175	3	3791	3603	-188
68	1792	888	311	2991	1609	933	290	2832	-159	3587	3195	-392
69	2109	1018	339	3466	2291	1008	346	3645	179	4096	4090	- 6
70	2214	1062	331	3607	2145	1046	336	3547	- 60	4256	3939	-317
Average								3226.9 1/	108.9 1/		3643.7 2/	180.3 2/

1/ Error per cent in the regional model $\frac{108.9}{3226.9} \times 100 = 3.37$

2/ Error per cent in the national model $\frac{180.3}{3643.7} \times 100 = 4.94$

SELECTED DATA ON THE DOUBLE PADDY RICE REGION

Year	t	Planted Area	Yield	Production	Deflated Price Received by Farmers Nov - Apr. Ave. Weighted By Marketings In Narrow Sense	Deflated Gross Return (Total cost-Self Service Inputs)	Rainfall in May-June in the Province
		t	t	t	t-1	t-1	t
Code	T	$DARC_t$	$DYRC_t$	$DQRC_t$	PRC_{t-1}	$DMRC_{t-1}$	DWt
		(1000 ha)	(MT/ha)	(1000MT)	(W/kg)	(W/ha)	(mm)
1961	1	633.3	3.033	1920.7	34.0	53527	117.9
1962	2	636.2	2.567	1633.4	32.1	62607	71.7
1963	3	643.0	3.306	2126.0	37.6	68596	376.6
1964	4	664.7	3.357	2231.5	51.2	137223	108.4
1965	5	685.3	2.933	2009.8	43.8	112451	60.1
1966	6	685.8	3.298	2261.6	37.6	72821	112.4
1967	7	689.8	2.798	1929.9	36.2	85463	104.5
1968	8	617.3	2.591	1599.7	36.6	69037	50.7
1969	9	682.4	3.358	2291.2	40.8	71761	108.4
1970	10	674.1	3.358	2144.5	40.4	99745	156.3

Table C.4

SELECTED DATA ON THE SINGLE PADDY RICE REGION

Year	t	Planted Area	Yield	Production	Deflated Price Received by Farmers Nov.-Apr. Ave. Weighted By Marketings In Narrow Sense	Deflated Gross Return (Total cost-Self Service Inputs)	Rainfall In May-June in the Province
		t	t	t	t-1	t-1	t
Code	T	$SARC_t$	$SYRC_t$	$SQRC_t$	PRC_{t-1}	$DMRC_{t-1}$	SW_t
		(1000 ha)	(MT /ha)	(1000 MT)	(W / kg)	(W / ha)	(m m)
1961	1	265.6	3.028	804.3	34.0	70107	123.8
1962	2	274.7	2.599	713.9	32.1	62447	58.6
1963	3	270.5	3.251	879.6	37.6	69798	255.8
1964	4	278.7	3.321	925.6	51.2	134405	90.7
1965	5	284.9	2.735	779.4	43.8	110874	21.2
1966	6	288.0	3.074	885.5	37.6	65376	76.3
1967	7	288.2	3.172	914.4	36.2	77357	92.1
1968	8	286.6	3.253	932.5	36.6	82731	44.3
1969	9	287.6	3.503	1007.7	40.8	98772	117.6
1970	10	285.3	3.664	1045.6	40.4	105607	141.1

Table C.5

SELECTED DATA ON THE UPLAND RICE REGION

Year	t	Planted Area	Yield	Production	Deflated Price Received by Farmers Nov.-Apr. Ave. Weighted By Marketings In Narrow Sense	Deflated Gross Returns (Total Cost-Self Service Inputs)	Rainfall In May - June in the Province
		t	t	t	t-1	t-1	
Code	T	$UARC_t$	$UYRC_t$	$UQRC_t$	PRC_{t-1}	$DMRC_{t-1}$	UW_t
		(1000 ha)	(MT/ha)	(1000 MT)	(W / kg)	(W / ha)	(m m)
1961	1	107.1	2.916	312.3	34.0	66089	88.0
1962	2	107.5	2.464	264.9	32.1	58856	30.3
1963	3	114.3	2.895	330.9	37.6	64720	145.8
1964	4	120.4	3.009	362.3	51.2	116162	161.3
1965	5	122.5	2.464	301.9	43.8	97203	57.4
1966	6	124.6	2.620	326.5	37.6	55186	132.3
1967	7	126.0	2.626	330.9	36.2	60929	68.8
1968	8	124.1	2.410	299.1	36.6	62739	55.7
1969	9	125.4	2.756	345.6	40.8	64376	89.4
1970	10	123.4	2.720	335.7	40.4	75407	70.8

Appendix D

Effect of Urbanization on Rice Yields

Historically, most Korean villages and cities were developed in the best fertile paddy land in the region. If one recognizes the above fact, we can assume that the suburban areas yield per hectare will be higher than that of the rest of the region as long as the other conditions are the same. However, rice yields per hectare in the suburban areas have been somewhat lower than that of the rest of the region according to recent yield data, even though overtime yields have been increasing in an absolute sense in urban areas.

The causes of these effects on paddy cultivation in the suburban regions may be pointed out as follows:

1. Relatively rapid land-value increases compared to purely agricultural regions; that is the farm lands are becoming targets of speculative investment by urban capital.
2. Increasing difficulties of hiring farm labor in competition with urban employment where wages are higher. Eventually, this tends to reduce hired labor inputs per hectare.
3. Relatively plentiful off-farm job opportunities for the surburban farmer compared with the rest of the region.
4. Destroying physical facilities of paddy land such as irrigation ditches, and canals due to the construction of housing and plant sites.
5. Air and water pollution.

To find out the relevant factors which contribute to extensifying of the paddy cultivation, additional data should be collected such as land values, wages, and the land buyers' objectives, etc.

Due to the lack of appropriate data in this area, a simple linear regression analysis was fit to test the hypothesis that yields in urban areas were declining relative to other parts of each region.

The percentage ratio of the yield of the cities and the neighboring counties over that of the rest of the region as a dependent variable Y, and time series from 1960 to 1970 as a dependent variable T.

The results of the simple linear regression by the regions are as follows:

1. Double Paddy Region:

   $$Yd = 111.99 - \underset{(1.48)}{1.127}\ T$$

   $r = -.44 \qquad SE. = 7.96$

2. Single Paddy Region:

   $$Ys = 106.8 - \underset{(2.87)}{1.77}\ T$$

   $r = -.69 \qquad SE. = 6.48$

3. Upland Region

   $$\frac{1}{U} = 96.47 + \underset{(.35)}{.26}\ T$$

   $r = .11 \qquad SE. = 7.90$

Except for the result from the upland region, the percentage ratio of yield in respect to the time series variable has a substantial negative relationship although not significant statistically in the double paddy region. Therefore, we may conclude that urbanization may well be having a detrimental effect on yields.

Table D.1

SELECTED DATA ON RICE YIELD

		Double Paddy Region			Single Paddy Region			Up Land Region		
	Code T	(A) The Region's Yield per Ha. Excluded 23 City & Pusan, Taegu & Kwangju Neighboring Counties (MT/ha)	(B) The Yield per Ha of the Cities' & Pusan, Taegu, & Kwangju Neighboring Counties (MT/ha)	B/A x 100 Yd	(A) The Region's Ave. Yield per Ha Excluded 12 Cities & Seoul, Daijeon's Neighboring Counties (MT/ha)	(B) The Yield per Ha of the Cities & Seoul, Daijeon's Neighboring Counties (MT/ha)	B/A x 100 Ys	(A) The Region's Ave Yield per Ha Excluding 7 Cities (MT/ha)	(B) The Ave. Yield per Ha of the 7 Cities (MT/ha)	B/A x 100 Yu
1960	1	2.499	2.764	110.6	2.986	3.088	103.4	2.868	2.821	98.4
1961	2	3.033	3.352	110.5	3.028	3.135	103.5	2.916	2.875	98.6
1962	3	2.567	3.192	124.4	2.599	3.021	116.2	2.464	2.592	105.2
1963	4	3.306	3.172	96.0	3.251	3.025	93.1	2.895	2.588	89.4
1964	5	3.357	3.170	94.4	3.321	3.026	91.1	3.009	2.603	86.5
1965	6	2.933	3.126	106.6	2.735	2.508	91.7	2.464	2.671	108.4
1966	7	3.298	3.456	104.8	3.074	2.820	91.7	2.620	2.493	95.2
1967	8	2.798	3.040	108.7	3.172	3.078	97.0	2.626	2.362	89.9
1968	9	2.591	2.576	99.1	3.253	2.943	90.5	2.410	2.471	102.5
1969	10	3.358	3.389	100.9	3.503	3.279	93.6	2.756	2.985	108.3
1970	11	3.181	3.230	101.5	3.664	3.156	86.1	2.720	2.615	96.1