Alternative Agricultural Pricing Policies in the Republic of Korea

Their Implications for Government Deficits, Income Distribution, and Balance of Payments

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ABSTRACT

The purpose of this paper is to evaluate quantitatively the impact of alternative pricing policies, aimed at reducing the deficits in the Grain (mainly rice and barley) Management Fund (GMF), and the Fertilizer Fund (FF) in Korea. In comparing these alternatives, we measure their impact on (i) production and consumption of rice and barley, (ii) real income distribution, including the income distribution in both and rural and the urban sectors, (iii) import levels of rice, (iv) self-sufficiency in rice and (v) the public budget. The standard operational methods for evaluating agricultural pricing policies, namely domestic resource cost (DRC) and effective protection rate (EPR) calculations and consumer-producer surplus calculations are insufficient for adequately answering all the questions posed above. Therefore, we have developed an operational methodology.

Our methodology can be viewed as extending the consumer-producer surplus method to include income distribution and some general equilibrium considerations at the cost of further complexity but stopping far short of a full detailed general equilibrium analysis. Instead we devised a two sector (rural and urban) multi-market model, which endogenously generates incomes (rents and wages) in the rural sector, while the incomes of urban residents are exogenously given. This approach may be viewed as a synthesis of the work on agricultural households models and the new public economics literature.

ABSTRAIT

Ce document évalue l'impact de diverses mesures de fixation des prix visant à réduire les déficits du Fonds de gestion des céréales (surtout du riz et de l'orge) et du Fonds des engrais en Corée. En les comparant, on peut mesurer leur effet sur i) la production et la consommation de riz et d'orge, ii) la répartition du revenu réel, y compris la répartition du revenu des secteurs rural et urbain, iii) les importations de riz, iv) l'autoapprovisionnement en riz et v) les finances publiques. Comme les méthodes normalement utilisées pour évaluer ces mesures (calcul du coût réel des ressources intérieures et du taux de protection effective et comptes de surplus du consommateur et du producteur) ne permettent pas d'apporter de réponse satisfaisante sur tous ces points, nous avons élaboré une nouvelle approche.

On peut la considérer comme une extension de la méthode des comptes de surplus du consommateur et du producteur qui englobe la répartition du revenu et quelques notions d'équilibre général; elle est donc un peu plus complexe que les méthodes traditionnelles, mais elle ne va pas jusqu'à une analyse complète et détaillée de l'équilibre général. Nous avons créé un modèle bisectoriel (rural et urbain) à plusieurs marchés où les revenus (loyers et salaires) dégagés par le secteur rural sont traités de façon endogène alors que les revenus des résidents des villes sont donnés d'une manière exogène. On peut voir dans cette approche une synthèse des travaux sur les modèles des ménages agricoles et des dernières publications sur l'économie du secteur public.

EXTRACTO

La finalidad de este documento es evaluar cuantitativamente el efecto de diferentes políticas de precios que tienen por objeto reducir los déficit del Fondo de Administración de Cereales (principalmente arroz y cebada) y del Fondo de Fertilizantes de Corea. Al comparar estas opciones, medimos su efecto en: i) la producción y el consumo de arroz y cebada; ii) la distribución de ingresos reales, que incluye la distribución de ingresos en los sectores tanto rural como urbano; iii) los niveles de importación de arroz; iv) la autosuficiencia en arroz, y v) el presupuesto fiscal. Los métodos operacionales corrientes para evaluar las políticas de precios de productos agrícolas, a saber, los cálculos del costo de los recursos internos y de la tasa de protección efectiva y los cálculos de los excedentes de consumidores y productores son insuficientes para satisfacer en forma adecuada todos los interrogantes planteados anteriormente. Por consiguiente, hemos elaborado una metodología operacional.

Puede considerarse que nuestra metodología amplía el método de excedentes de los consumidores y productores de forma de incluir consideraciones relativas a la distribución de ingresos y otras sobre el equilibrio general a costa de una mayor complejidad, pero que queda muy lejos de llegar a un análisis pleno y detallado de equilibrio general. En su lugar hemos ideado un modelo de multimercado con dos sectores (rural y urbano), que en forma endógena genera ingresos (salarios e ingresos no salariales) en el sector rural, en tanto que los ingresos de los residentes urbanos se presentan en forma exógena. Este enfoque puede considerarse como una síntesis del trabajo sobre los modelos de unidades familiares agrícolas y la nueva literatura sobre economía pública.

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Chapter I

Introduction

I.1 Purpose

The purpose of this paper is to evaluate quantitatively the impact of alternative pricing policies, aimed at reducing the deficits in the Grain (mainly rice and barley) Management Fund (GMF), and the Fertilizer Fund (FF) in Korea. In comparing these alternatives, we measure their impact on (i) production and consumption of rice and barley, (ii) real income distribution, including the income distribution in both the rural and the urban sectors, (iii) import levels of rice, (iv) self-sufficiency in rice and (v) the public budget. The standard operational methods for evaluating agricultural pricing policies, namely domestic resource cost (DRC) and effective protection rate (EPR) calculations [1/] and consumer-producer surplus calculations [2/] are insufficient for adequately answering all the questions posed above. Therefore, we have developed an operational methodology. [3/] In this chapter we shall briefly discuss the following: (a) the basic methodology, (b) the Korean problem, and the ways the basic model has been modified to handle the particular institutional details of Korea, (c) the data sources and the methods of estimation, and (d) the different policy scenarios analyzed.

1/ For example see P. Scandizzo and C. Bruce [1980].

2/ For demonstration of the application of this tool to the same problem of Korea's rice price policy, see Tolley-Thomas-Wong [1982], and Anderson [1981].

3/ For a similar approach concerning the agricultural sector alone and applied to Taiwan, China, see Lau, Yotopolous, Chou and Lin [1981]. For theoretical discussion of the Town vs. Country debate which underlies some of the main issues of this report see Brayerman-Sah-Stiglitz [1982].

I.2 Methodology

In evaluating the impact of changes in different taxes and subsidies we must remember the main reasons for the imposition of these taxes and subsidies in the first place. These are: (i) redistribution of income, (ii) generation of public revenues for public expenditures, (iii) correcting market failures and (iv) providing production incentives. In many LDC's, where the administrative infrastructure for income tax is still in its infant stages, commodity taxation is often the only feasible tax instrument. Taxation and subsidization of agricultural products and in particular, taxation and subsidization of main food items, is clearly one of the major issues of political economy in LDC's (and in developed countries as well). Hence, any operational tool aimed at providing a quantitative framework for the political economy discussion concerning alternative agricultural pricing policies must address these issues.

The two standard operational tools for evaluation of alternative agricultural pricing policies are not fully equipped to do so. The first method, which measures the domestic resource cost (DRC) and effective protection rate (EPR) of different taxes and subsidies, neither addresses the income distribution and public revenue issues, nor can it address the quantitative impact of these taxes and subsidies on production and consumption. The second method, calculation of consumers' and producers' surplus in its operational version, does not devote sufficient attention to income distribution beyond the classification of agents into consumers and producers, and is mostly used for addressing the impact of a single tax change. Where the impact of simultaneous changes of several taxes in a "normal," i.e. "distorted," economy have to be measured, one must consider the interrelation of different markets directly through substitution

possiblilities in production and consumption and indirectly through the impact on the labor market.

Our methodology can be viewed as extending the surplus method to include income distribution and some general equilibrium considerations at the cost of further complexity but stopping far short of a full detailed general equilibrium analysis. Instead we devised a "limited" two sector (rural and urban) multi-market model, which endogenously generates incomes (rents and wages) in the rural sector, while the incomes of urban residents are exogenously given. This approach may be viewed as a synthesis of the work on agricultural households models 4/ and the new public economics literature. 5/ It uses simple models of farm-household behavior as its basic building blocks. These models allow a microeconomic investigation of both producer and consumer response to exogeneous price changes within an integrated consumer-cum-producer framework. Variations in rural incomes are due to different sizes of holdings and different labor endowments. Through aggregation over households, aggregate supply and demand functions including those of labor are generated. Hence, we can evaluate the impact of price changes at the market level. In particular we can derive the marketed surplus functions, i.e. the net domestic supplies to the urban sector of rice and barley in the Korean case. In addition we can evaluate the impact of these price changes on the welfare of the individual household. In the urban sector, households, which differ in their exogenous incomes, are the micro entity. Through aggregation over the individual demand functions of urban

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4/ See, for example, Barnum and Squire [1979], and Ahn, Singh and Squire [1981].

5/ See, for example, Atkinson and Stiglitz [1980].

households, urban market demand functions are generated. The equilibrium conditions capture the particular institutional details of the market organization - i.e., perfectly competitive, imperfectly competitive or monopoly, the particular forms of government intervention and the different degrees of international trade. Different aggregation rules of real income changes over the individual households are based on differences in location, i.e. rural or urban and on differences in income. These rules allow us to compare different aggregate measures of society's welfare change.

Other important considerations are the data requirements of the model. As will be elaborated later in the text, and briefly in subsection I.4 below, the methodology is designed to handle different degrees of data availability.

I.3 The Korean problem

In its past rice price policy the Government of Korea (GOK) tried to fulfill the following three objectives:

(a) Achieving self-sufficiency in rice production;

(b) Maintaining rural incomes in parity with urban incomes;

(c) Keeping low prices in the cities in order to restrain urban workers' demand for wages increases.

Objectives (b) and (c) hold for barley too. (Korea is self sufficient in barley). In addition to these three objectives the GOK aimed at stabilizing urban consumers prices, especially of rice, during the calendar year and across years. We shall not deal in this paper with the price stabilization issue.

In order to fulfill the first three objectives, the GOK generated wedges between the rural prices and urban prices of rice and barley. These wedges, which constitute price support to farmers and subsidies to urban consumers, generated large deficits. The Grain Management Fund (GMF) (the system through

which the rice and barley price policies are executed) deficit was about 0.7 percent of GNP in the late 1970's. 6/ However, the subsidized prices for urban consumers of both rice and barley are still substantially higher than world prices.

In addition, fertilizers are produced domestically at guaranteed prices significantly higher than international prices. This is due mainly to two reasons: (a) Korea produces Urea out of Naphta rather than from natural gas, the cheaper source, and (b) the Korean government entered into disadvantageous joint ventures with foreign companies. By the Joint Venture Decree these companies are guaranteed both a rate of return on their capital and a volume of government purchases (all domestic demand is handled through government channels). These guarantees, the last of which is to expire in 1986, imply high price support for the fertilizer industry. To partially compensate farmers for the inefficient production of fertilizers, the government sells farmers fertilizers through the Fertilizer Fund (FF) at subsidized prices, i.e. prices lower than factory prices. The FF deficit was approximately 0.2 percent of GNP in 1979. The subsidized prices, though, are still above international prices. In 1979, they were about 20% higher than international prices. Hence, these fertilizer subsidies are really a tax on farmers and a transfer to the fertilizer industry. On the other hand the subsidized prices

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6/ The GMF deficit has been financed by direct loans from the Bank of Korea (BOK) and hence institutionally it was tied directly to increases in the money supply and inflationary pressures. Clearly, in principle it could have been financed from the general budget while other items of public expenditures be financed by direct borrowing from BOK. However, given that this type of financing was taking place, politically, the GMF (and similarly the FF) deficits were connected in the debate over the size of the budget deficit more to money creation than other components of government expenditures. Recently, however, the Gok has decided to finance the GMF from the general budget.

of rice and barley are really a tax on urban consumers, given lower international price. For the base year 1979, the rural price of rice was approximately 65% above the world prices and the urban price was approximately 50% above. For barley, the rural price was more than two and one half times the world price while the urban price was about 30% above.

The GOK decided to reduce both GMF and FF deficits. Since there are alternative ways to do so, and since the three commodities in question: rice, barley and fertilizers are linked through production and consumption to each other, the task of comparing the quantitative impact of these alternative policies on the conflicting targets of the GOK can be carried through the basic methodology outlined above. However, in tailoring the general methodology to the Korea problem, we had to respond to the particular institutional details of Korea. (See Appendix A on institutional details and Chapter II for the Korea Model). The most important considerations to be introduced here are the existence of two different types of rice, High Yielding Variety (HYV) and Traditional Variety (TV), and the actual operation of the GMF.

HYV rice and TV rice are two distinct products. TV is much preferred by consumers. However, to stimulate production and move towards self sufficiency in rice the GOK provides price support only for HYV. To encourage urban consumption of HYV, only HYV is subsidized. Clearly the degrees of substitution between these two products in production and consumption are critical in evaluating the impact of government price intervention in the HYV market alone. However, data is only collected in Korea for the aggregate commodity called "rice". The way we handled this problem is discussed in chapter II and Appendix B. Considering the functioning of the two markets, TV rice market is assumed to be perfectly competitive private market, while the

HYV market is assumed to be totally government controlled. It is true that for 1979 (the year to which the model is calibrated), the government did not purchase all the HYV produced. In addition to the government controlled market there exists a private market for HYV. However, the size of this market declined significantly in the early 80's with the reduction in total production of HYV. Therefore, for modelling simplification, we assumed that all the marketed surplus of HYV is purchased and sold only by the government. 7/ (See detailed description of the rice market in Appendix A).

I.4 Data sources and estimation procedures

The model is calibrated and analyzed for 1979 data. The basic tables underlying the model are provided in Appendix A. The parameter estimates are available in Appendix C. The estimation is based on farm household surveys collected in 1970 and 1977 by the Ministry of Agriculture (MAF). The demand functions are estimated using the Almost Ideal Demand System (AIDS). The main advantage of this system over the Linear Expenditure system (LES) is that it allows commodities to be inferior goods. Where disaggregated basic food items such as barley and HYV are considered, this is essential. AIDS has another merit. If data is scarce it can be collapsed into the Cobb-Douglas form which requires information only on budget shares. This is to be expected in data scarce countries such as many African countries. For production estimation we use the Translog profit function which also can be collapsed into a Cobb-Douglas form. In the Korean case, the simulation results using Cobb-Douglas and Translog forms were very similar. Therefore, for analytical simplicity we

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7/ However, it seems that for 1983 the government is considering again significant quantity control of the HYV market. In principle, our basic methodology can be extended to include this feature.

used the Cobb-Douglas form. Detailed discussion of all these issues is provided in the main text and in Appendices B and C.

I.5 Policy Scenarios

We model a variety of scenarios under two different assumptions concerning the rural labor market; (i) Assuming fixed wage i.e. perfectly elastic supply of labor, the Lewis assumption and (ii) perfectly inelastic supply of labor, which follows from the AIDS demand specification, when leisure is assumed separable from other commodities and migration is not allowed. The appropriate quantitative results lie between these two bounds.

The policy scenarios include:

(a) Single price changes

10% (20%) decrease in the rural price of rice (barley)

10% (20%) increase in the urban price of rice (barley)

20% increase in farmers' fertilizer price.

Raising farmers' fertilizer price to factory-gate price.

Lowering farmers' fertilizer price to international price.

(b) Multiple price changes

The simultaneous price changes considered here are aimed at eliminating the operational deficit of the GMF under alternative assumptions regarding farmers' fertilizer price. The policies examined are:

(i) decreasing rice and barley rural prices, excluding handling cost, to current urban price levels;

(ii) increasing barley and rice urban prices to the current level of rural prices.

(iii) allowing the two commodities to move in different directions, i.e. moving urban rice price towards the rural price while moving rural barley price towards its current urban level, and vice-versa.

(iv) Closed economy laissez faire.

(v) Free trade. None of the scenarios examined allow for rationing or quantitative controls to be used in government policy. The exact descriptions of all the different scenarios are provided in Chapter 3.

Chapter II

Model Description and Policy Scenarios

II.1 Introduction

The following model is designed to trace the impact of major policy changes on a variety of indicators of national welfare and economic activity. The formal structure of the model is reserved for Appendix B. This section presents an overview of its construction and operation.

The principal policy changes to be examined are all geared to the reduction of the deficit in the combined operations of the Grain Management Fund and the Fertilizer Fund. While there are many ways to reduce government expenditures on the agricultural subsidy programs, their impact on the economic well-being of the country and of particular sectors of the economy differ widely. The model is used to sort out these differential effects. The main alternatives are to raise the urban consumer prices, lower purchase prices received by farmers, increase farmers' fertilizer price and to try different degrees of free market policies including or excluding international trade in agricultural commodities.

Indicators of economic performance and welfare should react quite differently to these alternatives. The indicators of concern will be government deficits themselves (expected to be reduced in all versions), real incomes of various classes of rural producers-cum-consumers and urban consumers, and total production, consumption and imports of these commodities. Since a stated goal of the government is self-sufficiency, the last indicator is of great importance. From the effects on different income groups, aggregate values for "weighted" national income can be computed reflecting values the government may place on the various groups. In this

way, particular concern for the poor or for the rural sector vis a vis the urban sector may be incorporated.

The basic structure of the model is straightforward. The model explicitly considers the supply and demand for three consumer goods: High yield rice which is marketed and subsidized by the government, barley which is also subsidized and passes through government channels and traditional rice which is traded on private markets. Also included explicitly are the supply and demand of two factors of production: Chemical fertilizer which is government controlled and labor. Institutional detail is incorporated through the specification of market clearing conditions. The basic outcomes of the model are determined, however, by supply and consumption responses to the price changes engendered by the policy experiments.

These supply responses are themselves derived from underlying production functions for agricultural products faced by farm households. The consumption responses come from utility functions which characterize preferences for consumer goods in both farm and urban households. The use of production and utility functions was preferred to the direct use of supply and demand elasticities for a variety of reasons, even at the expense of simplicity and computational convenience. Following in the tradition of the farm household model incorporating production and consumption decisions (e.g. Barnum and Squire [1979]; Ahn, Singh and Squire [1981]; Yotopolous and Lau [1974],) features of the production structure are thought to influence the consumption behavior of the household. Profits from farm production yield income which influences food demand and marketed surplus. Information on supply response alone cannot be used to generate this income gain. In addition, factor demand is an essential feature of the current model. Fertilizer is directly marketed by the government and is a major element in the deficit. Labor time

valuation, and hence imputed income, determine much of "full" income. (On this concept see subsection II.3 below.) A full production structure is necessary to ensure consistency of the factor demands and output responses. Supply, then, is derived under the assumption of profit maximization subject to the production technology.

On the consumption side, demand curves are linked to utility functions in order to assess the welfare implications of consumer price changes involving a number of goods simultaneously. Since three commodities and labor supply all enter the model explicitly, it is important to have a framework in which all are consistently related. A second reason for relying on the utility function characterization of demand is to be able to use the concept of the compensating variation as a device for welfare comparisons. This allows us to incorporate insights and results from recent work in the public finance literature (e.g. Atkinson/Stiglitz [1980]).

The remainder of this chapter will examine the model in detail, beginning with the underlying production and demand structure and working up to the market clearing conditions.

II.2 Agricultural Production

The production structure assumed for all commodities is characterized by the translog restricted profit function (Lau [1976]). This is a flexible functional form in the sense that it can accommodate a large variety of substitution possibilities and factor demand elasticities. Inputs to production are classified into fixed and variable. Rents accruing to the fixed factor (land) are considered part of family income. The variable inputs to production are fertilizer, labor and other inputs. Since the farm is assumed to be competitive in factor markets, the family endowment of labor does not affect use and allocation of labor in production. If family labor is

too small to meet demand at current factor prices, the farm will hire in workers from outside. If the family is too large relative to demand, in the sense that the marginal product of family labor would be lower than market wage if it were used completely on the farm, then the family is assumed to hire members out. Therefore, profits on the farm are dependent on the prices of the variable factors and the quantities of the fixed factor. The profit function yields (as is discussed in Appendix B) the supply of the product, the demand for the factors of production, and directly, the net return to the farm from land ownership. These are all functions of the commodity and input prices.

While land is fixed to the farm, it is not necessarily fixed between uses. In particular, paddy land can be used in production of either high yield or traditional variety rice. The decision of how much land to allocate to each use is assumed to be governed by profit maximization principles as well. The equilibrium condition for land allocation is that the marginal revenue product of land in each use are equated. If this were not the case, transfers of land from the lower productivity use to the higher would always increase profits. When the model is in operation, a change in the administered price of high yield variety rice will induce a reallocation of land toward high yield varieties which will increase total profits but not without some cost in foregone earnings from traditional variety rice. The inclusion of substitution possibilities increases the realism of the model as far as the total effect on rice output and on rural income generation are concerned. Since barley is grown in a completely different season from rice, though usually on the same land, no explicit substitution is considered between these commodities. Indeed, the usual alternative to barley production is to leave the land to lie fallow, and there is no need to incorporate the

opportunity cost of barley into family income which is not already handled by labor time and factor costs. (There is a relatively subtle form of intertemporal substitution between barley and rice via the depletion of nutrients in the soil from barley production. This is, however, a bit too subtle for present concerns.)

II.3 Rural Incomes and Commodity Demand

Incomes in the rural areas are derived from three sources. The first is profit from barley and rice production as described above. The second is wage income or, as will be discussed below, the full value of the time of household members evaluated at the wage rate. The third is income from profits from non-agricultural pursuits. For the purposes of the simulation, the rural sector was divided into four groups, corresponding to the presentation of the large majority of the data from Korean sources. The division into classes was solely on the basis of the amount of land owned, taken from the Farm Household Economy Survey. The classes are: a) those owning less than .5 hectares (33.6% of the rural sector b) those owning between .5 and 1 hectare (34.3%), c) those owning between 1 and 1.5 hectares (18.2%) and d) those owning more than 1.5 hectares (13.9%).

Wages for farm workers are assumed equal across the classes. Data on rice and barley land owned by these classes as well as information on off-farm or non-agricultural earnings are also available from the Farm Household and Production Cost surveys.

Two versions of the model are used in this exercise corresponding to the definitions of income. The first and the most straightforward version uses disposable income which is broken into two components, profits from the rice and barley production and from other sources. In the simulation exercise only

profits will be affected by policy intervention, the other component being held fixed.

The second version uses the concept of "full" income associated with Gary Becker [1965]. In this case, the value of leisure time is incorporated into the model and "income" includes the value of the family's total time endowment. On the assumption that people choose the number of hours which they work, the opportunity cost of an hour of leisure is the amount earned by an hour of working, i.e. the wage. Full income, then, includes the entire time available to potential workers (e.g. 24 hours/day) evaluated at the wage rate plus profits and other non-labor income. The purpose of introducing this concept is to be able to derive "demand" functions for leisure and hence supply functions for labor. If the impact of price support policies on the agricultural wage is ignored, the appraisal of the welfare consequences of the policy options can be severely biased. Inclusion of a complete demand system which accomodates labor supply decision can shed considerable light on both the distributional effects of pricing policies and the effects on production.

The valuation of leisure raises the issue of comparability of urban and rural incomes and welfare. Popular wisdom on the subject would indicate that urban workers spend more time on the job than do their rural counterparts. If so, the value of the latter's leisure should be included in welfare comparison. Due to seasonality in the demand for labor in the rural sector, however, the valuation of this "leisure" time is problematic. For the sake of comprehensibility, the results reported will be in terms of disposable income derived from the implicit hours worked in the model.

The actual demand system to be used in the model is a flexible functional form akin to that used in the production side of the model. It was orginally

devised by Deaton and Muellbauer [1980] and dubbed the Almost Ideal Demand System (AIDS) (a somewhat unfortunate abbreviation these days!). Certain features of this model make it attractive in the current context. First of all, as in the translog production structure discussed above, this functional form can allow a greater variety of price elasticities to be determined by estimation or by a priori information than most other common demand systems. More important for the Korea case, however, is its flexibility with regard to income elasticities. Barley is generally considered to be an inferior good. 8/ Judging from summary reports of consumer expenditure surveys, the consumption of high yield variety rice tends to increase with income at low levels of income but to reach a peak and thereafter decrease with income. This inverse U shaped Engel curve is commonly encountered with foodstuffs at such a disaggregated level. The demand system chosen can accommodate that pattern rather than forcing the income elasticities to be positive everywhere. The implications of positive versus negative income elasticities are substantial in the Korean context since they will have very different consequences concerning the elasticity of marketed surplus and, hence, of the cost of government programs as farm prices are manipulated.

II.4 Urban Incomes and Demand

The urban sector is divided into four income groups of approximately the

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8/ The estimation of the demand curve for barley potentially posed a number of problems. Throughout most of the 1970's, the government imposed requirements that barley was to be mixed with rice in all public places. This would artificially increase the demand for barley and link that demand to rice consumption, especially in the urban areas. The estimation of total demand would then be quite complicated and difficult to extract from survey data. Fortunately, it was possible to ignore this effect in the current context. Estimation of individual demand was based on a 1970 sample survey which took place before the regulations were put into effect. The model is calibrated to fit 1979 aggregate figures, a date which is after these regulations had already been removed.

same size. Much less concern is given to the specification of income generation in the urban areas. In contrast to the rural sector, the source of the inequality in the urban income distribution is assumed to be only differences in the wages of the four classes. In 1979 the classes chosen were: a) disposable incomes less than 150,000 won/month (21.4%) b) incomes between 150,000 won and 210,000 won (24.3%) c) incomes between 210,000 won and 300,000 won (24.3%) and d) incomes over 300,000 won (30%). Since the wage structure and urban incomes are assumed to be fixed throughout most of the analysis, the specific cause for such differences is not of crucial importance.

Urban real incomes are dependent on the prices of consumer goods. A variety of price indices were examined. The one reported is the Stone index, specific to income group, which is a close approximation to compensating variations implicit in the AIDS framework. The AIDS demand system is assumed to behave the same in both the urban and rural areas, i.e. price elasticities of the sector average incomes are constrained to be the same.

II.5 Market Clearing

With the building blocks of the production and consumption decision rules in place, market clearing conditions are constructed to incorporate institutional details of the Korean economy.

The crucial relationships in the Korean context relates to the rice market. The market outcome for both types of rice and the land allocated between them are simultaneously determined. For high yield variety rice, the equilibrium condition for clearing is that total supply equal total demand. The former is composed of current production and total imports of rice from abroad. Current production is determined by the policy variables of the support prices of high yield rice and of fertilizer, both determined by

government choice. Imports are also completely controlled by the government, international trade being in official hands. While much of the rice imported by the government is actually of the traditional type and not the high yield variety, it is included in the market of the latter. This is due to the fact that the imports are of lower quality than usual traditional type rice and are marketed with rice going through government channels.

The demand side of the market is composed of three parts. Rural demand is determined by rural incomes and prices faced by farmers in the countryside. Both of these components are strongly influenced by government activity, high yield prices being a significant factor in rural incomes. Urban demand is determined by the sales price of high yield rice and all other consumer prices. The third major component of demand is a slack variable of sorts and represents rice lost to waste, vermin or to animal feed. It is calculated for the base year as a means of removing discrepancies between supply and demand but is a constant proportion of supply throughout the remaining analysis.

Two caveats should be mentioned here. First it is assumed that all high yield rice passes through government hands. This implies both that the government will buy all high yield rice at posted prices and that the price wedge generated by policy is not circumvented by arbitrage or black market operations by private citizens. While the first assumption has not held for some years in the recent past, the government has had an increasing share of the high yield market over the past few years and by now does control virtually the entire crop.9/ The second assumption can be justified on the basis of the relatively strict adherence to the law in Korean society. While

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9/ However, this may change in 1983. See footnote 7 above.

not a plausible assumption in many places in the world, the chance that the marketing laws are respected in Korea is high.

The second observation about the high yield market as described is that, as stated, the market may be "overdetermined" in the sense that enough variables are controlled by government that supplies may not necessarily equal demand. For instance, demand and supply may be determined to a large extent by government prices. If imports and inventories are also set arbitrarily by the government, then nothing assures material balances. This can be handled by alternative assumptions concerning how the government would react to discrepancies. The first method is to assume that imports will be used to fill in any gaps between urban demand and available rice. This simply removes one policy parameter from government control. Alternatively we can reinterpret the variable "imports" to be the sum of imports and inventory accumulated. Imports can then be determined by fiat but the consequences of market clearing would then be to induce unanticipated depletion or accumulation of stocks.

The traditional rice market is assumed to be in a private, closed economy equilibrium with the marketed surplus equalling urban demand (the surplus being net of animal feed and waste). The two markets are intimately linked through the land allocation decisions by farmers. The price of traditional, free market rice is ultimately influenced by government pricing policy. The line of causality would be that an increase in the producer price of high yield rice via policy, will increase the profitability of land in high yield cultivation. This induces farmers to shift out of traditional rice production, reducing its supply. The supply reduction will increase consumer prices. Thus the "free market" price of rice will follow the controlled price to a greater or lesser extent depending on the substitutability between the

grains in production. Ignoring the effect of this substitution would lead to underestimates of the impact of government activity on rural incomes and consumer prices. Conversely, ignoring differences between the rice varieties by aggregating rice into a single homogenous commodity would tend to overestimate the impact of government policy on incomes, prices and, of course, the deficit due to the rice sales.

The barley market, like high yield rice, is assumed to be completely in government hands. The purchase price of the government is the rural producer and consumer price, release price is the urban consumption price. Supply is entirely domestic as imports have never been significant. Market clearing is brought about by inventory accumulation or reduction if any discrepancy arises between the marketed surplus (essentially a function of rural prices) and urban demand. In recent years this discrepancy has been substantial, resulting in large increases in inventories.

Fertilizer supply is exogenous to the current model. The agreements between the government and foreign producers are assumed binding. Therefore, both total available fertilizer and its acquisition price are set from outside the system. Prices which farmers face are a matter of policy. The production structure yields the demand for fertilizer in rice and barley. The residual farm demand for fertilizer in other uses is assumed to be a function of the price also. Any discrepancies between total demand and contractual agreement supply is met by exports to world markets (total production has always run ahead of demand) and changes in inventory.

Four versions of the model can be run, each with a different assumption concerning the labor market. The results of two of these versions are presented in this report. A major advantage of detailed modelling of the rural sector is the ability to incorporate factor market conditions for the

analysis of output and income determination. The precise institutional assumption regarding labor market equilibrium are likely to have a substantial effect on the response of incomes to policy changes, particularly the effect of food prices on rural incomes.

The four assumptions are: a) the rural wage rate is fixed, b) the rural wage is endogenous, but the rural population and labor supply is fixed, c) the rural wage and labor supply are endogenous but the rural population is fixed, d) all three variables are endogenous.

The first assumption is consistent with the "unlimited supply of labor" models in development theory dating from the Lewis model. The results derived from this version will show the smallest impact of pricing policy on rural incomes: only profitability of crops will be affected by policy while using this assumption. Family endowments of labor will retain their original value. The market clears entirely by the demand for labor derived from the production function.

Fixing the labor supply but allowing the wage to vary to clear the market will have the strongest impact on rural income and welfare. A reduction of the purchase price of rice will lead to a decline in demand for labor. With supply fixed, this translates immediately into lower wages. The assumption of fixed labor supply is tantamount to assuming that the utility function is of a Cobb-Douglas type between leisure and goods. This is a special case of the AIDS System described above.

Only the results of the above two versions will be reported since they represent the possible extreme assumptions concerning the labor market. The remaining two versions can be considered for future extensions.

Allowing the supply of labor to vary in accordance to the utility function to be estimated is a compromise of the two previous cases. With a

properly estimated demand system, it is probably the case closest to reality for the short run. The short run here is defined as the time horizon within which no migration can take place.

The last assumption allows migration to affect the size of the rural population. The equilibrating factor in this version is the level of utility in the rural and urban sectors. One characterization of migration equilibrium is modelled by the equating average utility of the rural dwellers (a function of rural wages and prices) to that of the urban dwellers (a function of urban wages and prices). This version of the model is likely to have effects similar to the fixed wage case on income and prices since the option to migrate will add extra responsiveness to the labor supply function. It should point out, however, the intersectoral flows which might be expected from relaxing the policies which are supposed to benefit the rural sector. 10/

Finally, the deficits in the funds devoted to the government price policies are calculated in a straightforward manner. For the Grain Management Fund, the deficit is composed of the differential between purchase and sale prices plus handling cost times the marketed surplus. In the rice market, the costs are partly offset by sales of imported grain at higher urban prices. This is the implicit tariff revenue from importing cheap rice. Barley is not assumed to be traded except in the one version simulating complete free trade. The excess of supply over demand is assumed to increase inventories at cost to the government but with no implicit economic return. This sidesteps the intertemporal issues involved with inventory carry over and interest payments. For the Fertilizer Fund, the deficit is the differential of purchase and sales prices times the volume of sales to domestic consumers plus

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10/ For some discussion of current migration issues see Yusut et al. [1983].

cost of acquiring new inventories. This can be partly offset by some sales abroad at quite disadvantageous prices.

II.6 Calibration

The above model is calibrated to match the basic, aggregate facts of the Korean agricultural sector in 1979. Basic production structure parameters are determined either by direct estimates or by data available from the Production Cost Survey done by the Ministry of Agriculture and Fisheries for 1970 and 1977 (in this case, a Cobb-Douglas variant of the production system is used). Profitability of the crops is determined by using the assumed production system in conjunction with aggregate figures on output in order to generate the complete base period production structure. The consequences of using each of these sources of data are discussed in Chapter IV.

Similarly, demand parameters are used which generate base period quantities. Two demand systems are generated, one using econometric estimate from survey data and the other, referred to as the aggregate share version, uses only aggregate consumption values to calibrate the AIDS system and has implicitly unitary own price elasticities for the included consumption goods. Even with the estimated system, enough freedom to match actual aggregate figures is provided by shift parameters in the demand system which can be attributed to the effects of prices of other goods not accounted for in the estimation procedure. Details of the calibration and base period values appear in the Appendices.

Market clearing terms are known with a fair amount of confidence. Actual descrepancies between production, consumption and import figures become the constants representing waste and animal feed. In general, the aggregate numbers are used in the calibration procedure to put bounds on the estimated parameters of production and consumption. Once these values are determined,

however, the system is run in reverse with parameters taken as constant and the aggregate values of production and consumption allowed to change in response to policy changes.

II.7 Policy Scenarios - Descriptive Model

The deficits from the Grain Management and Fertilizer Funds have become very large in recent years. This burden has caused the government to search for ways to decrease the cost drastically. In order to provide answers most useful to the government, the model is used to analyze relatively large changes in the policy variables. All situations which are analyzed lead to smaller deficits. A principle type of situation for comparison is one in which deficits are eliminated completely. In addition, it is often useful to analyze small changes in each policy instrument to assess the sensitivity of results to individual price changes.

Since the number of possible policy regimes is quite large, they are presented in a series of tables designed to highlight the results of the main policy options. In each case, the characteristics of the economy affected by the policy are the same. These are presented in the form of percentage changes from the base period run with historical figures. The responses analyzed are:

1. Changes in the deficits of the rice, barley and fertilizer funds.
2. Total production, consumption and marketed surplus of rice and barley. Related to this is the self-sufficiency ratio of production divided by consumption. 11/

11/ Readers must be aware that referring only to a self sufficiency ratio may be very misleading, i.e. a large increase in urban consumer prices may decrease consumption substantially so as to achieve a 100% self sufficiency rate. However, the public notion of an increase in self sufficiency is usually associated with increased production under given real prices.

3. Changes in rural incomes, both on average and divided into the four classes. For some purposes, the fate of the rural sector as a whole is considered of primary importance. For some purposes, however the intrasectoral distribution of income is of concern.

4. Changes in urban incomes, as above.

5. Changes in the rural and urban consumer price index. Combined with the changes in incomes, the price index can be used to calculate real incomes and reflect the true cost of proposed policy changes.

6. Aggregate welfare measures. The main measures to be used are "weighted national income" where the real incomes of different groups are differentially weighted to reflect the importance of such groups to government decision makers. In one version, the income of the group will determine the weight, with poor people being counted more heavily than rich. In another, people in the rural sector may be given extra weight in the social welfare function reflecting the Korean government's concern for the status of the rural sector and the tendency to urban migration. One variant of the income weighted measure is the measure devised by Atkinson which evaluates the income of people with a particular function which reflects society's degree of aversion to income inequality.

The first set of results, presented in Table 1, examines the effect of changing one price at a time, holding all others fixed. These will point out the basic sensitivities of the economy to each of the policy instruments. For rice and barley, the policies examined are a) a small (10% or 20%) reduction in the rural price, b) a small (10% or 20%) increase in the urban price. c) price reductions in rural areas or increases in urban areas sufficient to

eliminate the deficit due to the single commodity, d) a move to international prices.

For fertilizer, the farmers' price is allowed to vary in both directions. First, a small increase and an increase to the contractual supply price to decrease the deficit is examined. However, since the contracts with the foreign companies are likely to be allowed to expire without renegotiation, price reductions for fertilizer to be examined should include a small decrease and one to match international prices.

The second major set of results, presented in Table 2, should show the effects of reducing the deficit in all funds. For fertilizer, this can be done either at the current procurement price or at world prices in anticipation of the expiration of the contracts and increased efficiency in fertilizer production. For the other commodities, a zero deficit will require the equation of urban and rural prices (after accounting for handling charges). The following options are examined: a) both rice and barley prices equal the current urban price, b) both equal the current rural price, c) one equals the urban, one the rural and vice versa, d) closed economy laissez-faire (all prices endogenous with zero imports) and e) open economy laissez-faire (all prices equal world prices).

Of these, the final option represents the greatest tilt toward the urban sector. Within the context of a closed (or mostly so) economy, option a) values the urban sector most, option b) the rural sector most, option d) is a compromise between the two. Options included in c) examine the possibility of taxing one commodity and subsidizing the other to achieve some balance between the two.

II.8 Sensitivity Analysis

Data quality and availability is often quite limited for the agricultural

sector of less developed countries. Even in the Korean case, sufficient doubt surrounds the basic data that computed parameters of the demand and production systems are subject to error, perhaps substantial error. It is important, therefore, to ensure that the results obtained in the full model simulations are not unduly sensitive to errors of the magnitude that might be expected in these parameters. The role of sensitivity analysis, in this case, is to make some appraisal of the reliability of the results of the project and to pinpoint the parameters which need to be known with precision.

The focus of the sensitivity analysis is done by changing assumptions concerning market equilibrium. In the current case, the alternative assumptions vis a vis the labor market is an example. Here, results would show the sensitivity of model output (particularly with regard to rural household income and welfare) to judgements concerning the institutional structure of the rural labor market.

More commonly, the values most subject to error are the underlying parameters of production and consumption. The method proposed to analyze the degree of sensitivity of model output to uncertainty regarding these values is to re-run the policy experiments with a variety of values of the parameters. The alternative values are determined by perturbing the estimated values (either in the estimated version or the aggregate share version).

Chapter III

Basic Results

III.1 Overview

The number of potential policies which can be examined within this framework is fairly large. Further, for each of the policy experiments, various assumptions concerning the institutional structure of the economy and the underlying behavioral parameters may be employed. The results, therefore, will be quite extensive. Discussion of the results will be divided into three parts. In this chapter, the most important common threads which run through the analysis will be discussed first. Following these very broad conclusions will be a more detailed discussion of the way in which the model works under a wide variety of the assumptions mentioned above. This will give a fairly clear picture of the effects which the proposed policy changes are most likely to have on the Korean economy. While many of the qualitative results and the basic story are invariant to particular specifications of the model, a number of conclusions are sensitive to such changes. In chapter IV the implications of the various different ways of modelling the labor market, the income distribution, the structure of demand and the structure of production are discussed.

The various solutions to the model throw into sharp relief the interaction, both complementary and competing, of the various goals of the government: deficit reduction; increasing the real income of the public, particularly in the rural sector; moderation of the cost of living in the urban areas; improving the distribution of income; and, finally, approaching

self sufficiency in grain consumption, particularly of rice. A distinct pattern emerges concerning the effects of the proposed policy changes on the government deficit and other indicators of national welfare.

The first main conclusion is that there is no way in which to satisfy all of the goals of the government by simply changing the prices in the Grain Management and Fertilizer Funds. The goals are essentially in competition with each other and basic choices must be made concerning the relative importance of each. To a large extent, the various goals may be grouped into two broad sets which are usually in direct conflict with each other. In one group are: a) the interests of the larger farmers or, depending on assumptions concerning the rural labor market, the rural sector as a whole and b) the achievement of self-sufficiency. In the other group are: a) large reductions of the deficits with small changes in the values of policy instruments, b) moderation of the cost of living in the urban areas, c) increasing national income, and d) improvement of the lot of the very poor. 12/ The first set of goals is promoted by maintaining current rural grain prices and raising urban release prices. The second is furthered by reducing the support prices. Hence, if the pricing policy of the two agricultural funds is the only type of policy available, 13/ a basic choice must be made between the rural and urban sectors concerning who it is that must bear the burden of the deficit reductions.

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12 This last point may seem surprising since the rural sector is on average, less well off than the urban. However, the distribution of income is considerable more dispersed in the cities and it is there that the very poorest live.

13/ Other policies might include changing the tax system, increasing rural technology extension services or supporting rural off-form employment opportunities.

The second broad result of this exercise is that the proportional effects of most of the examined policy changes on the government deficit are much larger than the proportional effects on private sector production and incomes. Further, price reductions in the rural sector have considerably more impact on the deficits than comparable increases in the urban area. Substitution possibilities, both in supply and demand relations, moderate the impact of policy variables on the people, but exacerbate the effect on government expenditure. On the supply side, the existence of traditional rice as an alternative use of rice land leads to large elasticities of supply of high yield rice and moderates the impact of a subsidy reduction on farm incomes. On the demand side, a reduction of the support price may benefit people in the rural sector as consumers. While the reduction in the cost of living does not offset the reduction in incomes for all surplus producing farmers it does provide a moderating influence for that particular policy. Similar stories may be told for each of the rural sector policy interventions. The greater the substitution possibilities on the supply side, the greater will be this mediating effect on incomes.

The third broad conclusion is that in two markets there appear to be fairly straight-forward solutions to the budget problems. In the barley market, the loss in welfare of the rural producers engendered by a reduction in the barley price is relatively small since even with the large subsidy, the profitability of barley has always been low. As a result, a reduction in price lowers output to a large extent, though incomes are not severely affected. Since the supply response to price is so large, the effect on government costs in the barley fund are drastically reduced when the price is lowered. The only real goal (other than some loss in farm income) which must be sacrificed is the desire to encourage barley consumption for its

micronutrient content. Even on these grounds, gains in nutritional status are facilitated by trade for barley which is cheap on world markets.

The other relatively unambiguous conclusion is that the Fertilizer Fund operations serve simultaneously as a drain on resources and as a direct tax on agriculture. It is already the intent of the Korea government to let current committments to the foreign fertilizer producers expire, allowing for improvements in efficiency of the domestic industry. The results of this study confirm this as a desirable decision. Decreasing the home production and letting the fertilizer price reflect international costs, helps achieve three other policy goals. Deficits due to fertilizer, currently at 19 percent of the total Grain Management and Fertilizer fund deficits can be eliminated from the start. Total food production at current prices will rise, thus contributing to the self-sufficiency goal. The expected gain in rice production is near 3 percent if world prices of fertilizer are used. 14/ At the same time, the reduced price of this input raises the income of all farmers. Since many of the examined policy choices will entail reductions in rural incomes for the sake of government expenditure, the reduction in fertilizer cost can be partial compensation for the farmers and still help in the deficit.

The hardest questions, those in which the various governmental goals are in direct competition and in which the predicted consequences are both larger and more sensitive to model specification, surround the rice markets. Therefore, for much of the subsequent discussion, policies concerning rice

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14/ Some doubt surrounds this figure. It has been proposed that fertilizer price currently would have an asymmetric effect on fertilizer use and output. Since fertilizer use has increased substantially in recent years it is possible that further use due to price reductions would be very small. Reductions in use due to price increases, however are likely to be larger.

will take center stage and the other policies will be discussed essentially as adjuncts to the rice problem.

Finally, the Government of Korea has generally been considering policies in the context of a closed agricultural economy, i.e., one with little international trade. On the basis of the simulation results, it appears that the most crucial decision to be made by the government concerns the value of self-sufficiency. Deficits in either of the grain markets can be essentially eliminated by closing the price gap between rural and urban sectors. 15/ However, if this is done in a closed economy, the opportunity of generating either substantial government revenues or substantial price reductions in the basic food grains for consumers would be lost. The results presented here tentatively assess the size of these potential gains. To a large extent, the basic tradeoff between the rural sector on the one hand and the government budget and urban sector on the other hand, involves the decision of how much agricultural imports to allow. Further examination of the agricultural sector would require information on the value of foreign exchange to the economy as a whole in order to assess the full costs involved in the choice between autarky and international trade.

III.2 General Results

For the sake of simplicity, the results of only two of the versions of the model will be presented. The basic results of the simulation exercises are presented in Tables IA and IB which show the effects of changing one price at a time, and in IIA and IIB which involve changing prices in all markets in order to eliminate all operating deficits. (All the tables are presented in subsection III.4). The first set reveal the basic sensitivities of the main

15/ Abstracting from inventory accumulation and handling costs.

indicators to individual components of the proposed policies. The second set captures the important interactions between these policies. The "A" tables represent the model with the assumption of a fixed supply of labor and variable wages in the rural sector and use the econometric estimation of demand parameters described in the appendix. The "B" tables employ the assumption of fixed wages in agriculture and use a simplified version of the demand system with unitary own price elasticities. The differences between the two versions reflect most of the basic sensitivities inherent in the analysis. Given that Korea does not appear to be a "surplus labor" economy and that the demand parameters for Version A are derived from econometric evidence, Version A is certainly the preferred model. Its superiority is strongest for short run analyses where the labor force is fixed in the rural sector. The alternative Version, B, is included in order to see the effect of major changes in specifications.

Except for the self-sufficiency ratio, the entries in the table reflect the percentage change in the variable indentified by the column heading when the policy described by the row heading is put into effect. The self-sufficiency ratio applies to only rice and is the actual value of the term: (total rice consumption - rice imports)/total rice consumption. National real disposable income is the weighted sum of changes of disposable income of all eight groups plus the reduction of the deficit. This number reflects the total gain in purchasing power of the economy, including the government. If taxes were reduced by the same amount as the government deficit reduction, this number would represent total percentage increases in private income adjusted for price changes. This number does not take into account the influence of the policies on the income distribution. The final columns are the values of the changes in "Social Welfare" in which income groups are given different weights. The deficit is assumed to be distributed to the public on

a per capita basis 16/. The higher the value of the parameter, ε , (see notes at end of table for the definition of the Atkinson measure of welfare) the more the poor are valued relative to the more affluent. As ε becomes very large, only the very poor are counted in the evaluation of social welfare (this being Rawls' [1970] criterion of justice).

III.2.1 Rice Market Interventions Reducing the Rural Support Price

The cost of operating the Grain Management Fund was approximately 3.5 percent of total central government expenditure in 1979. Closing the gap between urban and rural prices, therefore, has potential for generating important revenue gains. Responses of the economy to the reduction of the

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16/ This assumption implies a very progressive tax rebate scheme. There are other possible ways to redistribute the tax revenue though none affect the results very much. Taxes may be reduced in proportion to those paid. This would benefit the urban sector most - and the relatively affluent within the sector especially. As a result, this measure would be a bit lower as groups with little weight in the welfare function would get most of the government revenue. A second possibility is to give the extra onsources to the poor, either by reducing taxes borne by the poor or by redirecting government expenditure. This would raise this measure, the more so for large values of ε. Finally, the government revenue may be used to compensate the people who are adversely affected by a deficit reducing policy. For the rural price reduction, this means returning the deficit gain to the rural sector, particularly to larger farmers. This has ambiguous effects on the social welfare measure (relative to per capita revenue distribution) but holds open the possibility of removing all objections to the policy. Unfortunately, full compensation is not possible from the increase in government revenue due to rural price reductions. Besides purely fiscal means of financing the deficit, there exists the possibility of simply increasing the money supply or borrowing in capital markets. Indeed, a combination of these has been the way in which the GOK has financed the deficit until summer 1983. The distributioned consequences of these changes in macroeconomic policy are difficult to identify. Hence, instead of analyzing the monetary effects, we transformed these effects into direct income effects via tax changes, and analyzed alternative distributional consequences. There is clearly a need to assess the distributional implications of reduction in deficits associated with monetary changes. However, the recent change in Government financing of GMF and FF, i.e., shifting them to the General budget, make our model description more accurate.

rural price by 10 percent and to the urban price are presented in rows a and b in tables IA and B. An immediate result to note is that substitution possibilities make the government deficit very sensitive to the purchase price of high yield variety rice. When the amount of subsidy is reduced, the supply of high yield variety rice falls quickly as land is transferred to traditional strains. The supply elasticity of HYV rice ranges from about 1 to 1.5. On the other hand, production of traditional rice picks up much of the slack and increases with an elasticity which averages about .9. The net supply response of both rices taken together is between .2 and .5, which is in line with many previous estimates of short run supply elasticities of rice. 17/ The government incurs costs only on the purchases of high yield variety rice. Therefore, even though total supply elasticities for the composite crop of rice are modest, the supply elasticity relevant to the government deficit is extremely high. Furthermore, since the price of high yield rice falls, the on-farm consumption of rice increases as well which further decreases the marketed surplus. The deficit falls because of the reduced purchase price and the sharply curtailed sales by farmers.

Farmer income is also directly affected by a reduction in the purchase price. Due to the assumptions concerning substitution possibilities between the types of rice (see Appendix B), a reduction in the producer price of high yield rice results in an equal percentage reduction in the price of traditional variety rice. The extra production of the latter types depresses its price in the private market. Therefore, profits from both rice strains decline. In the versions where rural wage rates are sensitive to demand, wages decline as well. To the extent that the substitution assumptions made

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17/ See, for example, Tolley et al.

here are too strong, the reported effects exaggerate the reduction in rural incomes.18/ As a first approximation, though, the substitution possibilities assumed here are probably fairly accurate; historically, the acreage of high yield did in fact respond quite sensitively to an increased subsidy rate.

The gain in government revenue resulting from the reduction of purchase price can be decomposed into two parts - the saving of operating costs and the gain in "tariff" revenue. The former simply reflects the reduction in the gap between purchase and sales prices and the attendant reduction in production. The latter is an indirect result of relaxing the import restrictions which are necessary to clear the HYV rice market. With constant urban prices (and demand) and reduced marketed surplus from the countryside, the HYV market clears by increasing imports. Since world prices of rice are lower than the current urban prices, the government gains revenue from the profit on these sales. These earnings are equivalent to those which would be generated by levying a tariff on imports equal to the gap between urban and world prices. The two components are logically separable and it is a bit deceptive to include the tariff gains as part of the reduction of the Grain Management Fund cost though it is certainly net revenue to the government as a whole. The relative magnitude of the two sources of income is illustrated in row b in which the rural price is set equal to the urban price (minus handling costs) in order to eliminate the operating deficit of the rice fund. In the absence of tariff revenue the decrease in the deficit could only be about 40 percent,

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18/ If substitution possibilities between the two grains are smaller than assumed, neither the decline in prices (and profits) from traditional rice nor the decline in labor demand and wages would be as large as reported here. By the same token, the gains in government revenues would not be as high either. Similarly, if the supply of labor was not perfectly inelastic (in contrast to table IA), the impact on the wage component of income would be smaller.

that is, the contribution of rice to total deficit in the base period. However, since imports increase to a large extent (to between 19 and 28 percent of consumption) the tariff revenue is equal to a large fraction of the cost of the fertilizer and barley funds, and option b reduces the deficit by 60-98 percent. Caution should be taken at this point, however, since some doubt surrounds the assumption that Korea can import rice at constant international prices. If some monopsony power in world markets exists, the cost of imports would rise. However, since the price differential between urban and world prices is so high (world prices are 33% lower), a large scope remains for revenue gains. In scenario a, where prices are reduced by only 10 percent and imports increase to between 12 and 13 percent of consumption, the total gain is between 30 and 50 percent in the deficit, a substantial amount of money.

The revenue savings from this policy is offset to some degree by possible increases in the barley and fertilizer fund deficits. In some versions of the model, lower rice prices lead to larger sales of barley to the government and tend to increase costs in that fund. In all versions of the model, the reduced total supply of rice leads to less use of fertilizer. This is especially true since, in general, the high yield variety of rice requires more fertilizer then does the traditional. Even though the Government sells fertilizer to farmers at a loss, farm use is better than letting the fertilizer go unsold or be dumped on world markets. The large reductions in the rice deficit are offset to a small extent by the resultant increases in fertilizer and perhaps barley.

Since the potential government deficit reduction is so large, and the loss to each farmer appears much smaller in percentage terms, the issue of compensation arises. If by redistributing the revenue gains to the farmers

who suffer a decline in real income, the government can cover this loss, a strong case can be made for phasing out an inefficient subsidy system. Direct payments to the farmers from tax decreases or their equivalent from general funds may be substituted for the subsidy in order to obtain the reduction in the cost of living for urban workers and rural smallholders. Unfortunately, no such direct repayment is feasible. While the total deficit reduction is large, the reduction per rural household (or per acre) is not sufficient to compensate all farmers for the price reduction solely through the increase in government revenue. The gains to the urban sector would have to be recaptured, in part, to make compensation possible. It is interesting to note, however, that the reduction in real disposable income of the larger farmers can be limited to 2 to 6 percent with compensation (by acreage owned) in contrast to 7.5 to 14.6 percent without it.

The big gainers when rural prices are lowered are urban consumers and, if wages are fixed, the rural poor. The urban cost of living is reduced since the price of traditional rice everywhere falls with the rural price of HYV. These cost savings can be as high as 1 percent of the urban cost of living. For the landless and small farmers (who are net importers of rice), the substantial reduction of the price of both varieties of rice lowers the cost of living by about 4 percent in the case of zero operating deficit. When wages are flexible, the reduction of demand for labor and hence, of wages leads to losses of income in excess of this fall in the cost of living.

Aggregate Measures of Welfare

Since some members of society gain and others lose, the user of any summary measure of welfare or economic performance must be willing to compare standards of living across individuals. The measures used here employ different weighting schemes designed to reflect social distaste for

inequitable income distributions. The first measure, total personal income, does not weight people differently and so measures the net gain or loss in personal purchasing power. Government expenditure gains are evaluated on an equal dollar for dollar basis with private incomes and no premium is given for foreign exchange earnings. For the two scenarios which reduce the high yield price, the country-wide real disposable income increases by between .16 and .61 percent with a 10 percent decrease in price and by between .36 and 1.21 percent when the rice fund operating costs are zero. Thus, while decreases in rural incomes are larger per family than the increases in urban and small holder incomes, the fact that the urban sector is almost three times as large as the rural sector determines the final direction of aggregate income change.

It is possible to incorporate a concern for income distribution by evaluating changes in income differently depending on the degree of affluence of the person affected. An extra dollar received by a relatively poor person could be considered more valuable than one received by a wealthier person. A variety of such measures are available for this purpose. The one chosen is the "Atkinson measure" defined in Appendix B and at the end of table IA. In the last columns of the tables, the results given are the changes in this measure with each policy. The higher the value of ε , the more important is the change in a poor person's status relative to that of a wealthier person.

Since the rural sector, on average, is less well off than the urban sector, one would expect that the more sensitive to the poor is the measure of welfare, the less attractive the policy of reducing the rural price will appear. However, the actual results are more complicated than this. Since the very poorest segment of society live in the urban sector, very "inequality averse" evaluation criteria will improve with the reduction of their cost of

living. The order of magnitude of this change is about one percent for the case of reducing the rural price to the urban level. When the rural poor also benefit from the price fall, this effect is even stronger. When inequality is not an issue at all, the same general conclusion arises. However, for some of the intermediate cases, where the distribution of income is of concern to the policy maker but does not take the extreme form of caring only about the very poorest group, the opposite effect is found. In these cases, the harm done to the rural sector on average outweighs the gain to the urban sector. Thus, as shown in the columns where $\varepsilon = 1$ and 2 in table Ia, a reduction in the rural price of rice leads to a reduction in the measure of total welfare of .34 to .89 percent. This result points out the importance of specifying the overall goals and objectives of such policies very clearly. It is not sufficient to say that the distribution of income is important. It is necessary to specify "how much" in a relation to other goals of the government.

Migration

The model is explicitly short-run in nature and is not designed to examine migration decisions in detail. However, certain long-run possibilities are suggested by using different assumptions about the labor market. In the short-run, the versions with endogenous wage rates apply. Wages, in the space of one crop year, can fall giving the large predicted decline in rural incomes (Table 1A, C). These versions assume that the size of the rural population and labor force is fixed. One way of examining the long-run consequences of the policy changes is to allow migration sufficient to maintain the real wage in agriculture. The assumption, which follows a long tradition in development theory, is that the real wage is constant. The case which corresponds to this assumption is Table 1B. Here, instead of declining demand for labor reducing the wage and incomes, the effect is

entirely on the number of labor hours used. The reduction in demand can roughly be associated with outmigration from the rural sector. If this is true, the two alternative policies would cause (or speed up) migration by 6 percent and 10 percent of rural families, respectively.

Summary of Rural Price Reductions

In summary, reductions in the support price of rice will, on the "pro" side, benefit net consumers of rice, decrease the deficit of the GMF substantially and increase measures of weighted national income. Offsetting this is a decline in the real incomes of farmers who sell rice to market and a potentially substantial sacrifice of the self-sufficiency goal of the government. These are the major tradeoffs which the government must address.

Urban Price Increases

The second set of policies involve increasing the urban price of HYV rice. This is of particular importance since the Government of Korea considers this method the leading contender for alleviating the deficit. These results are found in rows C and D of all versions of Table I.

The consequences of this option are significantly different from lowering the support prices. The demand for rice in the urban areas can be expected to go down significantly, the elasticity of the decline ranges from -1 to -.4 in the runs examined. Since the rural price is left unchanged, total production is relatively fixed (small changes occur in order to accommodate changes in relative consumption of HYV to traditional rice in the urban sector). As a result, the smaller demand for rice will lead to fewer imports. By the calculations found in this analysis, Korea could come very close to self-

sufficiency in rice and may end up exporting some on average. 19/

Government expenditure is reduced by approximately the same percentage as the increase in the urban price. The fact that the numbers are so similar is coincidental. The reason that the decline in the deficit is so much smaller when urban price is raised as opposed to when the rural price is raised is that a) the total level of marketed surplus is left unchanged, therefore, for small changes in price (rows a and c) there is no supply response magnifying the deficit decline and b) the implicit tariff revenue declines as imports decline and, when exports are expected, there is a loss sustained on unprofitable exports.

Since rice supply, rural incomes and urban nominal incomes do not change at all, the deficit is reduced (albeit by less than via the rural price changes) and the country moves closer to self-sufficiency, this policy seems to be quite attractive. However, there are hidden costs imposed by this policy which the government may want to consider. The urban cost of living rises to a substantial extent. For the poorest urban group, increasing the price of the basic staple grain by 10 percent reduces their real disposable income by between .9 percent and 1.2 percent. If the rice deficit is to be closed, this becomes 2 to 3 percent. For the urban sector as a whole, the increase in prices reduces real income by 1.5 to 1.6 percent when the deficit is eliminated. The per capita income loss in the urban area when prices rise is smaller than the loss with rural price reductions. However, since the

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19/ It should be noted that these calculations abstract from any income growth or population growth in the urban sector and should not be interpreted as a prediction that the country would actually export rice. The import bill, though, would certainly be much reduced, helping to achieve greater self-sufficiency.

urban sector is so much larger than the rural sector, the total loss to the national economy is larger when the urban price is raised. Column 3 of Table I gives the change in national disposable income in real terms. This number includes the savings in government revenues from reducing the deficit. When the policy impact on the various classes are weighted by their incomes, these results are strengthened. Again, since the urban poor are both numerous and most deprived in society, measures of welfare which are dependent on the income distribution will respond badly to increases in urban prices. This general conclusion is invariant to the choice of aversion measure discussed above.

The tradeoff facing the government considering this policy is between self-sufficiency and deficit reduction on one hand versus loss of purchasing power in the urban sector. If this increase in the cost of living leads to higher wage demands, a secondary effect on the cost of export goods may result.

III.2.2 Barley Market Policies

In many ways, the analysis of policy intervention in the barley market is easier than in rice. Profits in barley are relatively modest. They are estimated to be near 23500 won/ha in the base year as opposed to 115500 won/ha for high yield rice. This has two main consequences for proposed price reductions in rural areas. First, the net impact on incomes is very small. The reduction in profits (small to begin with) is relatively minor. A 20 percent reduction in the price of barley reduces nominal disposal incomes of the largest producers by about .4 percent in the fixed wage case and by less when wages fall. On the other hand, consumption of barley is relatively larger in the rural sector than in the urban. Rural residents, as consumers, have this price decline cushioned to some extent. Indeed, with prices

determined completely by government fiat, many farmers may become net importers of barley when prices fall. This is the case for the simulations presented here. On balance, then, the cost to producers is low.[20/]

One difficulty arises from the formal model which illustrates an important problem with the barley fund. Since the country does not currently import barley, the conclusion that the rural sector as a whole is a net importer of grain when the price falls 20 percent is unusual. The implication is that most of the nation's supply comes from government release of inventory accumulated in the past years. Clearly the policy is not sustainable over any significant period of time. When this inventory is exhausted (within two to three years at the implied rate), the chosen prices become infeasible and prices to consumers would be bid up or reliance on international trade will be necessary.

The alternative policy of increasing urban price has mirror-image welfare implications and long run problems. Since barley takes such a small fraction of expenditures, the proposed price increases have little impact on welfare. As opposed to the rice market case, the gain in government revenues due to raising urban prices roughly compensates the increase in cost of living when evaluated on a dollar for dollar basis. On welfare grounds, raising the price in urban areas is not very damaging. However, as in the rural price scenario, the long run implications of maintaining this policy pose serious problems. Raising the urban price of barley to close the barley fund deficit reduces the total demand for barley. The exact amount of the reduction depends crucially

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[20/] A word of caution is required, though, here since the current model abstracts from regional variation in barley production. In certain regions of the country, barley production is a major contribution to income and a policy of price reduction may have a more serious impact than national averages would show.

on the demand parameters. In the estimated case (Table IA) the demand is very inelastic and the reduction is small. There is already considerably more production then consumption, giving rise to large annual increases in barley inventories. This is an unsustainable policy and a large waste of resources 21/. Reducing demand can only make an untenable situation worse. So, while the welfare effects of the proposed changes are modest, the scope of feasible policies is limited by material balance concerns in the absence of international trade. One obvious candidate for eliminating the deficit and ensuring equation of supply and demand is to mimic the behavior of a private market (by setting the corresponding prices) or to allow private trade in barley (eliminating government storage and handling). With relatively elastic supply, the equilibrium price will be very close to the current rural price (a reduction of 3-5%) and much of the burden will fall on the urban consumers (Table II row e). However, this cost is modest and the government would save approximately 15 percent of the total GMF deficit. The goal which would be sacrificed is the encouragement of barley consumption for nutritional reasons. Since demand is relatively inelastic for barley, though, absorption of increased production via the price mechanism is limited. If increased consumption is desired, per se, other methods such as education or advertising will be needed if large deficits and unstable inventories are to be avoided.

21/ In 1983 Korea has achieved its record barley harvest. This calls for a large increase in inventories and in deficit. It is interesting to note that the Government paper, the Korea Herald, devoted a full editorial in June to persuade consumers to shift their consumption pattern in favor of barley. It is very unlikely, though, that in the short or even medium run Koreans' tastes will change significantly to absorb such large barley production.

III.2.3 Fertilizer Fund Interventions

Since the Government of Korea is already planning to eliminate the contracts for production of fertilizer by the foreign investors, much of the current analysis is merely confirmation of the wisdom of this decision. The most interesting comparison to be made in considering the effect of fertilizer sale price changes is between selling at current purchase prices (to appraise the income effect of eliminating the current deficit) and selling at world prices (to appraise the maximum response to be expected when the present agreements are phased out).

The basic conclusion drawn from the simulations is that the present high fertilizer price (relative to world prices) serves as a direct tax on agricultural incomes. Raising the price to current purchase price would obviously eliminate the deficit, but at the expense of rural incomes. Without further policy changes the urban sector is unaffected. The reduction in the deficit is due, directly, to the elimination of fertilizer fund costs and indirectly by reducing the production and marketed surplus of the grains. Lower grain sales reduces the grain management deficits by nearly the same amount as the direct reduction in the fertilizer fund when the Cobb-Douglas specification of technologies used. These deficit reductions come directly at the expense of rural incomes, by reducing profit per acre for crops. The predicted differences in disposable income for cases where the sale price is between the factory price and the world price is about 1.4 percent for the largest farmers, when wages are held fixed, and about 2 percent when wages are endogenous.

The calculation of the impact of fertilizer prices is sensitive to assumptions made concerning the underlying production functions. Conventional wisdom concerning the use of fertilizer indicates that additional application

of fertilizer would have very little impact on output and, therefore, that the Cobb-Douglas specification using average share data would overstate this factor's marginal contribution. Modifying the translog specification to capture the implied inelasticity of factor demand yields much less impact on production and deficits in the grain management fund. The benefit of lowering the price to world levels on self-sufficiency and the benefit of raising price on the grain funds are both moderated by incorporating this a priori information on production into the model. The basic effect under these circumstances is on rural incomes. In the long run, reliance on world prices can benefit the farmer as a partial compensation for grain support price reductions.

III.3.1 Multi-Market Interventions

Policies which entail closing the gap between purchase and release price in all three markets are presented in Table II. Rows 1a and b present the case in which the rural prices of both rice and barley are reduced to their urban level. Rows 2a and b show the case in which both prices are set to their current rural level. Rows 3a and b show the case in which the barley price is lowered and the rice price raised and Rows 4a and b show the reverse case, where rice prices equal the current urban level and barley prices equal their rural level. What distinguishes case a from case b in these scenarios is the treatment of fertilizer. In each of these runs, row a entails raising the release price of fertilizer to the current contractual factory price, thereby losing no money on each unit sold. Case b entails lowering the release price to world levels, thereby simulating the case in which home production of fertilizer is required to compete with potential supplies from abroad. Since both of these cases imply some cost to the government given current institutional arrangements, the overall deficit is never actually

reduced to zero. When fertilizer prices are raised to purchase price, some of the supply which the government is obligated to buy will be left unsold. When they are lowered, a gap is opened between purchase and release prices again which lead to increased deficits.

The final two scenarios examined in Table II are far reaching policies of special interst. Row e simulates the case of a free market economy which is closed to international trade in agricultural products. This can be interpreted either as a case in which the government turns all marketing operations over to the private sector or, perhaps more realistically, where the government attempts to mimic the behavior of a private market but maintains control of the grains for seasonal stabilization purposes. Row f presents the case in which the economy is opened to free trade in agricultural products. This case assumes that Korea is a price taking country in the relevant markets i.e., that these prices are determined entirely outside of the country. Qualifications to the numerical results presented here will be necessary to the extent that Korea can influence the price of traditional rice, which it is most likely to import.

Many of the effects of scenarios 1 to 4 in this table are similar to the sum of the effects of their constituent policies. For example, in row 1a where barley and rice prices are lowered to their urban levels and fertilizer prices are raised, the net effect on rural incomes and production is roughly the same as would be found by adding the effects of rows b, d and j in table 1 in which each of these changes occur separately. However, a number of deviations from this general rule show up and provide some lessons for overall policy formation.

First of all, it is of some interest to see how much the rural sector might be hurt if all prices are changed to their disadvantage (row 1a), and

how much the urban sector is hurt when all policies favor farmers (row 2b). Again, these numbers depend on the particular model examined, but in the flexible rural wage case, the fall in the income of the largest farmers is on the order of 15 percent when there is a general urban bias in policy. For the rural sector as a whole, the number is around 12 percent. The deficit is essentially eliminated but the self-sufficiency ratio falls to about 84 percent. The value of national real income rises by about .3 percent.

When the rural sector is favored in the three relevant policies, the urban cost of living rises by about four and half percent. The deficit is reduced by about 40 percent (this being far from 100 percent due to the existence of the fertilizer deficit) and the country is essentially self-sufficient in rice, since rice consumption falls by 5 to 6 percent. The overall measure of national income falls by three percent. The differences between strong rural and strong urban biases in policy formation are, therefore, quite substantial.

Second, one important lesson emerges from the simultaneous consideration of the available policies. When considering a reduction in the rural price of grains, the substitution possibilities on both the supply and demand sides imply that rice and barley prices should be changed together. While there is no direct substitution between barley and rice in production, being grown in different seasons, there appears to be an indirect effect through effects on the cost of labor. Thus, if the reduction of the support price of rice results in a reduced demand for labor, barley production may be encouraged if

wages are flexible. 22/ Since the two grains are substitutable in demand, the added production of barley and the decreased demand both lead to increased marketed surplus. This leads directly to increased government costs. To illustrate the net effect, we can compare the deficit reduction in row 1a to the sum of deficit reductions in rows b, d and j in Table IA. When all markets experience a price change, the deficit is reduced by 93 percent as opposed to a sum of 83 percent for the individual changes. The difference of 10 percent is due to the fact that part of the deficit is no longer shifted from the rice market to the barley market and vice versa. To avoid this offset, the two substitutable goods should be treated in the same way. If one of the rural prices is to be lowered, it is advisable to lower the other at the same time.

The same argument, however, cannot be made in the case of urban price increases. In this case, the substitution effect (in consumption alone) increases the effectiveness of price changes on government deficits if the price change occurs in isolation. In this case, for example, an increase in the price of rice would lead to an increase for the demand for barley and, therefore greater revenue in the barley fund. This would tend to reinforce the deficit gains of increasing rice prices. The admission of substitutability leads to the general rule that urban prices may be treated independently, the spillover effects do not interfere with policy

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22/ Again, this is most likely to be the case in large barley producing regions. Also, the issue of seasonality arises at this point. As modelled, no distinction is made between rice and barley seasons. If the labor markets in both seasons are substantially independent of one another (i. e. wages follow a seasonal pattern and do not merely reflect average annual productivity) these results would need to be modified. In particular, the impact of a drop in barley prices would have much less effect on the wage rates relevant to rice production and vice versa.

effectiveness. However, care must be taken when dealing with the rural sector where the possibility of spillovers may hamper the effect of single price changes in reducing the deficit.

III.3.2 Free Trade and Closed Economy Laissez Faire

Examination of every possible policy agenda is impossible. Two natural benchmark cases, however, are those which mimic the effects of allowing a free private market to operate in agriculture. The results presented here are for the cases with and without international trade.

The closed economy model is presented in row 5 in table II. This shows the case where the government tries to imitate the workings of the private economy in the abscence of world trade. In the case where there is no uncertainty as to the level of production, this is exactly the same result as if the government were to leave the agricultural marketing business completely. If a private market is subject to price or yield uncertainty (due to weather or farmer uncertainty concerning other farmers' production plans) the results presented here would not be the same as if a competitive market actually existed. These results are the combined effects of the average price which the market would have generated plus the effect of government price stabilization. The assumption is that the farmer knows the price of his product with certainty.

When the current subsidy program is eliminated but the economy is isolated from world markets in the closed economy laissez faire case, both the urban and rural sectors share the burden of removing the deficit. However, the urban sector seems to absorb most of the costs. In the barley market, the very large elasticity of supply ensures that the equilibrium price of barley will not fall very far. The original (actual 1979) rural price of 267 won/kg falls to 250 won/kg. This has little effect on the rural sector but

represents almost a doubling of the urban price of barley. In high yield rice, the equilibrium price is 4 percent lower for the rural sector but 15 percent higher for the urban sector. The effect on the urban sector is mitigated however, by the fact that the price of traditional rice falls by the same amount as the rural price fall. Overall, rural real disposable incomes fall by between .36 percent and .81 percent while urban disposable incomes fall by between .45 percent and 3.5 percent.

Starting from the closed economy equilibrium, the effect of opening the agricultural sector to trade allows us to isolate the gain attributable to deficit reduction and that attributable to trade effects in the analysis of rural price reductions already discussed. It can also be of interest per se as a means of assessing the costs implied by the pursuit of self-sufficiency.

Table II row f (both versions) shows the results for a full, free trade equilibrium. The results should be considered suggestive rather than definitive since there is substantial doubt surrounding the ability to import at constant prices. Assuming prices to rice with imports has the effect of moderating all changes.

The most important item to note is the change in the goal of self-sufficiency. Due to the difference in demand assumptions, there is a wide range in which this value could fall: .48 for the fixed wage (high supply elasticity) and high demand elasticity for rice case to about .73 for the endogenous wage, estimated demand parameter case. While substantially different, both cases imply a significant compromise of the self-sufficiency goal. As stated above, we place a lot more confidence in the endogenous wage, estimated demand parameter case and hence we believe the decline in self sufficiency to be of smaller magnitude.

On the other hand, the gain in national disposable income is also

substantial, increasing by 2-3 percent in one year. This gain aggregates the very large gain in the urban sector with the devastating reduction in farm income. The free trade case is the most dramatic illustration of the basic tradeoffs exposed in this model: self-sufficiency and rural incomes on the one hand; national income, urban incomes and budget relief on the other.

While the presented free trade scenario is unrealistic, the results show the opportunities available in relaxing on the margin the autarkic position of Korean agriculture.

III.4 Tables describing the alternative policy scenarios.

Table 1A

Single Price Changes

Rural Wage Endogenous, Using Estimated Demand Parameters

	Deficit Change due to Government Domestic Expenditures 1/ (A)	Deficit Change due to Tariff Revenues 2/ (B)	Total Deficit (A)+(B)	Self Sufficiency Ratio of Rice (Base Year = .93) 3/	National Real Disposable Income 4,5/	Rice Supply			Rice Demand	Barley Supply	Barley Demand
						Total	HYV	Traditional			
High Yield Variety Rice Prices											
1a. Rural Price decreases 10%	-22.2	-9.8	-32.0	.88	.13	-5.90	-11.41	3.18	.43	4.64	-4.88
1b. Rural Price decreases to Urban level	-36.6	-21.8	-58.4	.81	.32	-13.29	-25.45	7.2	1.00	9.96	-10.26
1c. Urban Price Increases 10%	-20.6	1.0	-19.6	.94	-.44	-.07	-.68	.95	-1.10	0	1.29
1d. Urban Price Increases to Rural level (26.8%)	-35.0	14.1	-49.1	.96	-1.11	-.18	-1.70	2.38	2.86	0	3.19
Barley Prices											
1e. Rural Price decreases	-17.5	4.7	-12.8	.96	.012	1.64	3.46	1.46	-1.38	-35.5	4.84
1f. Rural Price decreases to Urban level (54.1%)	-26.3	9.1	-17.2	.98	.02	3.14	6.65	-2.80	-2.64	-79.87	17.06
1g. Urban Price Increases 20%	-0.9	-0.3	-1.2	.93	.005	0	-1.09	.152	.16	0	-2.05
1h. Urban Price Increases Rural level (118%)	-3.9	-1.1	-5.0	.93	.02	0	-4.65	.65	.67	0	-9.64
Fertilizer Prices											
1i Raised 20%	-6.35	-0.7	-7.05	.93	.018	-.70	-1.04	-1.86	-.16	-3.92	-.21
1j. Raised to Purchase Price	-15.75	-2.0	-17.75	.92	.029	-1.91	-2.73	-.54	-.44	-7.95	-.47
1k. Lowered to World Price	6.82	0.7	+7.52	.94	-.028	.67	.94	-.181	.12	2.81	.20

Table IA Cont.

		Rural Real Disposable Income [6]				Urban Real Disposable Income [7]				Atkinson Index [8,9]				
		1	2	3	4	1	2	3	4	ε=0	ε=.5	ε=1	ε=2	ε=∞
Ia.	Rural Price decreases 10%	-3.54	-5.01	-5.78	-6.94	.62	.62	.62	.62	.13	-.16	-.34	-.63	1.37
Ib.	Rural Price decreases to Urban level	-7.24	-10.25	-12.35	-14.62	1.48	1.48	1.48	1.48	.32	-.23	-.40	-.83	1.95
Ic.	Urban Price Increases 10%	0	0	0	0	-.91	-.73	-.63	-.55	-.44	-.37	-.31	-.19	-.60
Id.	Urban Price Increases to Rural level (26.8%)	0	0	0	0	-2.28	-2.10	-1.59	-1.08	-1.11	-.95	-.79	-.52	-1.40
Barley Prices														
Ie.	Rural Price decreases	-2.82	-2.01	-1.51	-1.02	0	0	0	0	.012	-.20	-.28	-.42	.40
If.	Rural Price decreases to Urban level (54.1%)	-4.32	-3.18	-2.22	-1.30	0	0	0	0	.02	-.33	-.42	-.72	.70
Ig.	Urban Price Increases 20%	0	0	0	0	-.02	-.02	-.02	-.01	.005	.007	.008	.011	.088
Ih.	Urban Price Increases Rural level (118%)	0	0	0	0	-.10	-.08	-.07	-.06	.02	.03	.04	.05	.04
Fertilizer Prices														
Ii.	Raised 20%	-.48	-.49	-.49	-.51	0	0	0	0	.018	.008	-.002	-.017	.195
Ij.	Raised to Purchased Price	-1.28	-1.31	-1.33	-1.39	0	0	0	0	.029	-.001	-.030	-.075	.488
Ik.	Lowered to World Price	.459	.467	.475	.494	0	0	0	0	-.028	-.020	-.012	0	.209

Table IB
Single Price Change
Fixed Rural Wage, Using Unitary Price Elasticities

		Deficit Change due to Government Domestic Expenditures 1/ (A)	Deficit Change due to Tariff Revenues 2/ (B)	Total Deficit (A) + (B)	Self Sufficiency Ratio of Rice 3/	National Real Disposable Income 4/, 5/	Total	Rice Supply HYV	Rice Supply Traditional	Rice Demand	Barley Demand	Barley Demand
High Yield Variety Rice Prices												
Ia.	Rural Price decreases 10%	-24.38	-21.7	-46.08	.84	.61	-5.7	-14.14	9.96	6.7	0	-.62
Ib.	Rural Price decreases to Urban level	-50.40	-48.2	-98.60	.69	1.21	-11.6	-30.74	24.05	16.10	0	-1.24
Ic.	Urban Price Increases 10%	-15.31	4.8	-10.51	.98	-.14	0	0	0	-3.6	0	0
Id.	Urban Price Increases to Rural level (26.8%)	-29.37	6.0	-23.37	1.03	.37	0	0	0	-8.5	0	0
Barley Prices												
Ie.	Rural Price decreases	21.30	0.5	-20.80	.94	.31	0	0	0	0	24.35	4.7
If.	Rural Price decreases to Urban level (54.1%	16.10	1.0	-15.10	.94	.40	0	0	0	0	-62.07	81.9
Ig.	Urban Price Increases 20%	-2.75	0	-2.75	.94	-.02	0	0	0	0	0	-13.5
Ih.	Urban Price Increases Rural level (118%)	-16.24	0	-16.24	.94	.14	0	0	0	0	0	-44
Fertilizer Prices												
Ii.	Raised 20%	-8.88	-1.7	-10.58	.93	.09	-.92	-1.41	-.02	0	-3.49	-.04
Ij.	Raised to Purchase Price	-22.34	-4.7	-27.04	.93	.22	-2.50	-3.82	-.04	0	-9.24	-.03
Ik.	Lowered to World Price	9.37	1.7	11.07	.94	-.1	.89	1.37	.015	0	3.45	.04

Table IB Cont.

		Rural Real Disposable Income 6/				Urban Real Disposable 7/				Atkinson Index 8, 9/				
		1	2	3	4	1	2	3	4	ε=0	ε=.5	ε=1	ε=2	ε=∞
Ia.	Rural Price decreases 10%	.41	-1.61	-2.76	-3.93	.56	.47	.39	.26	.61	.52	.41	.28	.60
Ib.	Rural Price decreases to Urban level	1.42	-2.81	-5.15	-7.49	1.28	1.06	.88	.59	1.21	1.02	.86	.64	1.35
Ic.	Urban Price Increases 10%	0	0	0	0	-1.25	-.82	-.47	-.07	-.14	-.22	-.35	-1.08	-1.21
Id.	Urban Price Increases to Rural level (26.8%)	0	0	0	0	-3.09	-2.02	-1.17	-.18	.37	.22	.26	.28	-2.89
Barley Prices														
Ie.	Rural Price decreases	.32	.19	.11	-.01	0	0	0	0	.31	.33	.35	.38	.06
If.	Rural Price decreases to Urban level (54.1%)	1.26	.98	.74	.38	0	0	0	0	.40	.33	.35	.38	.04
Ig.	Urban Price Increases 20%	0	0	0	0	-.02	-.02	-.02	-.025	-.02	-.017	-.015	-.022	-.007
Ih.	Urban Price Increases Rural level (118%)	0	0	0	0	-.09	-.09	-.09	-.09	.14	-.07	-.07	-.09	-.03
Fertilizer Prices														
Ii.	Raised 20%	-.11	-.21	-.28	-.32	0	0	0	0	.09	.01	.01	.01	-.03
Ij.	Raised to Purchase Price	-.25	-.57	-.73	-.88	0	0	0	0	.22	.04	.02	.03	.09
Ik.	Lowered to World Price	.08	.21	.27	.31	0	0	0	0	-.1	-.05	-.05	-.05	-.03

Table IC

Rural Wage Endogenous, Unitary Price Elasticities

		Deficit Change due to Government Domestic Expenditures 1/ (A)	Deficit Change due to Tariff Revenues 2/ (B)	Total Deficit (A) + (B)	Self Sufficiency of Rice Ratio 3/	National Real Disposable Income 4/, 5/	Rice Supply Total	Rice Supply HYV	Rice Supply Traditional	Rice Demand	Barley Demand	Barley Demand
High Yield Variety Rice Prices												
Ib.	Rural Price decreases to Urban Level	-46.42	-38.2	-84.62	.72	.88	-9.04	-25.61	21.90	15.80	3.6	-1.76
Id.	Urban Price Increases to Rural level (26.8%)	-31.27	7.9	-23.37	1.03	-.37	0	0	0	8.5	0	0
If.	Rural Price decreases to Urban level (54.1%)	-17.38	3.9	-13.48	.97	.28	3.06	5.51	-1.53	0	-59.13	76.75
Ih.	Urban Price Increases Rural level (118%)	-16.24	0	-16.24	.94	.14	0	0	0	0	0	-44
Ij.	Fertilizer Price Raised Raised to Purchase Price	-19.6	-4.1	-23.7	.92	.13	-1.95	-2.81	-.33	0	-7.95	

Table IC Cont.

		Rural Real Disposable Income 6/				Urban Real Disposable 7/				Atkinson Index 8,9/				
		1	2	3	4	1	2	3	4	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=\infty$
Ib.	Rural Price decreases to Urban level	-6.2	-9.1	-10.6	-12.5	1.28	1.06	.88	.59	.88	.54	.22	-.31	1.32
Id.	Urban Price Increases to Rural level (26.8%)	0	0	0	0	-3.09	-2.02	-1.17	-.18	-.37	-.79	-.72	-.59	-2.89
If.	Rural Price decreases to Urban level (54.1%)	-.25	-3.8	-3.8	-4.5	0	0	0	0	.28	.23	.17	.08	.05
Ih.	Urban Price Increases Rural level (118%)	0	0	0	0	-.09	-.09	-.09	-.09	.14	.09	.08	.07	-.002
Ij.	Fertilizer Price Raised Raised to Purchase Price	-.81	-.95	-.98	-1.12	0	0	0	0	.13	.11	.09	.06	.09

TABLE II A
MULTIMARKET INTERVENTIONS
Rural Wage Endogenous, Fully Estimated System

		Deficit Change due to Government Domestic Expenditures 1/ (A)	Deficit Change due to Tariff Revenues 2/ (B)	Total Deficit (A) + (B)	Self Sufficiency Ratio of Rice 3/	National Real Income 4/, 5/	Rice Supply Total	Rice Supply HYV	Rice Supply Traditional	Rice Demand	Barley Demand	Barley Demand
IIai.	Rural Rice and Barley Prices to Urban level; Fertilizer Price rises to Government Purchase Price	-74.7	-4.1	-78.8	.903	.18	-5.79	-9.48	.458	-2.44	-76.88	8.04
IIaii.	As above with world Fertilizer Price	-62.55	-1.0	-63.55	.924	.03	-3.10	-5.42	.814	-2.11	-73.92	13.15
IIb.	Rural Barley Price falls to Urban level; Urban High Yield Rice price rises to farmgate level	-70.19	6.6	-63.59	.864	.40	.864	2.41	-1.76	-4.34	-78.29	16.6
IIc.	Urban Prices both rise to farmgate levels	-52.94	5.3	-47.64	.929	1.47	-1.97	-3.93	1.34	-1.44	-7.91	-8.80
IId.	Urban Barley Price rises to farmgate level; Rural High Yield Rice prices fall to Urban level	-43.87	-13.1	-56.97	.849	-.03	-8.81	16.33	3.93	.801	-2.97	-14.3
IIe.	Closed economy laisse faire equilibrium			1.00	1.00	-1.5	2.83	3.88	1.06	-4.25	-28.22	-.94
IIf.	Free Trade equilibrium			1.00	.731	2.48	-23.5	-39.9	4.26	-.69	-83.15	-12.94

Table II-A Cont.

		Rural Real Disposable Income 6/				Urban Real Disposable Income 7/				Atkinson Index 8,9/				
		1	2	3	4	1	2	3	4	$\varepsilon=0$	$\varepsilon=.5$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=\infty$
IIai.	Rice and Barley Prices to Urban level; Fertilizer Price rises to Government Purchase Price	-10.61	-10.65	-10.77	-11.22	.73	.73	.73	.73	.18	-.40	-.66	-.98	.80
IIaii.	As above with world Fertilizer Price	-9.40	-9.42	-9.50	-9.76	.73	.73	.73	.73	.03	-.32	-.59	-.89	.75
IIb.	Rural Barley Price falls to Urban level; Urban High Yield Rice price rises to farmgate level	-5.98	-4.3	-3.47	-2.71	-1.18	-1.18	-1.18	-1.18	-.40	-.85	-.82	-1.00	-.28
IIc.	Urban Prices both rise to farmgate levels	-1.28	-1.31	-1.33	-1.39	-2.40	-2.40	-2.40	-2.40	-1.47	-1.35	-1.24	-1.04	-1.10
IId.	Urban Barley Price rises to farmgate level; Rural High Yield Rice prices fall to Urban level	-5.3	-7.2	-8.2	-9.46	-.51	-.51	-.51	-.51	-.03	-.26	-.40	-.58	-.78
IIe.	Closed economy laisse faire equilibrium	-1.15	.135	.8	1.52	-4.63	-3.89	-3.63	-3.50	-1.5	-1.3	-1.01	-.57	-1.15
IIf.	Free Trade equilibrium	-18.7	-20.6	-24.8	-28.7	8.25	7.47	6.70	6.20	2.48	.88	-.77	-3.82	6.74

Table IIB

Multi Market Interventions

Fixed Rural Wage, Unitary Price Elasticities

		Deficit Change due to Government Domestic Expenditures 1/ (A)	Deficit Change due to Tariff Revenues 2/ (B)	Total Deficit (A) + (B)	Self Sufficiency Ratio of Rice 3/	National Real Disposable Income 4,5/	Total	Rice Supply HYV	Rice Supply Traditional	Rice Demand	Barley Demand	Barley Demand
Rural IIa-i.	Rice and Barley Prices to Urban level; Fertilizer Prices rises to Government Purchase Price	-66.3	-29.7	-96.	.77	1.21	-8.89	-19.96	11.77	7.93	-62.12	68.71
IIa-ii	As above with world Fertilizer Price	-52.6	-24.0	-76.6	.81	1.09	-5.86	-15.32	11.82	7.93	-56.82	68.72
IIb-i	Rural Barley Price falls to Urban level; Urban High Yield Rice price rises to farmgate level	-51.95	2.1	-49.85	.96	.35	-2.50	-3.80	-0.7	-4.66	-62.12	70.29
IIb-ii	As above with world Fertilizer Price	-35.92	11.3	-24.62	1.00	.19	.89	1.39	-.02	-4.66	-56.82	70.29
IIc-i	Urban Prices both rise to farmgate levels	-50.13	2.1	-48.03	.98	.08	-2.50	-3.82	-.04	-4.66	-9.24	-15.72
IIc-ii	As above with world Fertilizer Price	-30.0	11.3	-18.7	.99	-.13	.89	1.37	.015	-.467	3.45	-15.57
IId-i	Urban Barley Price rises to farmgate level; Rural High Yield Rice prices fall to Urban level	-64.5	-29.7	-94.2	.77	.43	-8.89	-19.98	11.81	7.93	-9.24	-16.46
IId-ii	As above with world Fertilizer Price	-46.7	-24.0	-70.7	.81	.77	-5.86	-15.35	11.86	7.93	3.45	-16.33
IIe	Closed economy laisses faire equilibrium			-100	1.00	.90	-.09	-1.09		-3.55	-3.06	-13.57
IIf	Free Trade equilibrium			-100	.48	3.33	-20.10	-63.68	61.25	58.60	-68.91	115.0

Table IIB Cont.

		Rural Real Disposable Income 6/				Urban Real Disposable 7/				Atkinson Index 8,9/				
		1	2	3	4	1	2	3	4	ε=0	ε=.5	ε=1	ε=2	ε=∞
IIa-i	Rice and Barley Prices to Urban level; Fertilizer Prices rises to Government Purchase Price	1.49	-1.41	-3.08	-4.83	.66	.55	.46	.31	1.21	1.3	1.41	1.5	2.84
IIa-ii	As above with world Fertilizer Price	1.72	-.84	-2.34	-3.97	.66	.55	.46	.31	1.09	1.19	1.26	1.38	2.64
IIb-i	Rural Barley Price falls to Urban level; Urban High Yield Rice price rises to farmgate level	.86	.31	-.05	-.48	-1.63	-1.06	-.61	.09	.35	.3	.16	-.15	-.33
IIb-ii	As above with world Fertilizer Price	1.25	1.05	.89	.02	-1.63	-1.06	-.61	-.09	.19	.2	.11	-.07	-.98
IIc-i	Urban Prices both rise to farmgate levels	-.25	-.57	-.73	-.89	-1.71	-1.15	-.70	-.01	.08	.07	.01	-.14	-.46
IIc-ii	As above with world Fertilizer Price	.82	2.11	2.76	3.13	-1.71	-1.85	-.70	-.01	.13	.05	.00	-.16	-1.24
IId-i	Urban Barley Price rises to farmgate level; Rural High Yield Rice prices fall to Urban level	.30	-2.32	-3.76	-5.18	+.58	+.47	+.37	+.23	.43	.38	.20	.23	3.02
IId-ii	As above with world Fertilizer Price	.58	-1.67	-2.96	-4.22	+.58	+.47	+.37	+.23	.77	.22	.15	.12	2.40
IIe	Closed economy laisses faire equilibrium	.04	-.20	-.34	-.48	-1.49	-.99	-.59	0	.90	.42	.96	1.03	1.11
IIf	Free trade equilibrium	6.10	-1.42	-5.95	-10.63	7.94	5.65	3.83	1.03	3.33	3.35	3.74	4.21	10.54

Notes to the Tables

1/ This part includes the change in government costs due to the price differential multiplied by quantity processed plus the handling cost.

2/ This part includes the change in the government deficit due to changes in tariff revenues, e.g. if the rural price of rice is decreasing, there will be a reduction in the marketed supply of rice and in order to equilibrate the market at these prices, rice imports will increase. The increase in imports which are sold to urban consumers at a price higher than the purchase price of imports, the international price, increases government revenues and hence reduces the government deficit.

3/ (Total consumption - imports) ÷ total consumption. Expressed in levels.

4/ Total private real disposable income plus the reduction in total government deficit.

5/ Real disposable income = (nominal full income - value of leisure) ÷ P where P is the price index from the demand system.

6/ Income classes by size of landholding.
1 - less than .5 hectare
2 - .5 to 1.0 ha
3 - 1.0 to 1.5 ha
4 - more than 1.5 ha

7/ Income classes by wage income.
1 lowest 21.4%
2 next 24.3%
3 next 24.3%
4 highest 30%

8/ Atkinson index = $\bar{Y}\left[\sum_i \left(\frac{Y_i}{\bar{Y}}\right)^{1-\varepsilon} N_i\right]^{\left(\frac{1}{1-\varepsilon}\right)}$

where $\bar{Y}$ is mean real income
N_i is fraction of population in class i.
Y_i is real income of class i

For $\varepsilon = 0$, the measure is average private real income; for $\varepsilon > 0$, an "inequality equivalent" real income, with increasing ε representing increasing inequality aversion.

9/ Government expenditure reductions are assumed to be redistributed on a per capita basis.

Chapter IV

Consequences of Alternative Model Specifications

IV.1 Introduction

Regardless of the particular version of the model analyzed, the overall story told about the Korean agricultural economy remains qualitatively the same. However, various choices the investigator has in designing the model have interesting consequences for the actual numerical values in the results. While the estimates of the supply and demand parameters are estimated from econometric methods, some residual uncertainty surrounds their use. Similarly, while every effort was made to capture the essential institutional structures of the Korean rural economy, there can still be differences of opinion concerning the assumptions of farmer behavior or technological possibilities in agriculture. In this chapter, comparisons of different formulations are made, and lessons concerning the effect of the choices necessary made in setting up the model are drawn. For the Korean context, this allows a more complete understanding of the way the model works and allows for assessments of the effects of potential changes in it. For the prospects of applying the model in other places, this chapter will point out the substantive consequences of what may seem arbitrary or unimportant choices of model building.

In general, the set of assumptions which underlie the Model "A" (fixed labor supply, variable wages and estimated demand parameters), tend to accentuate the effect of rural price reductions on the income and welfare of the rural sector and make the deficit appear most resistant to reduction by means of small policy changes. On the other hand, Model "B" (fixed wages, elastic demand) tends to underplay the impact of policy on rural incomes and makes deficit reduction a very simple matter. This indicates that the more

substitutability that is built into the demand and supply structure, the more quantities will change with the implied policy interventions (affecting self-sufficiency and overall consumption and production levels) and the less will real incomes change (both in nominal terms as in the rural sector and in cost of living calculations in the urban sector). The following sections examine variations in demand and supply parameters, rural labor market structure and intrasectoral income distribution.

IV.2 Demand Parameters

Since survey data of reasonably high quality was available for Korea, econometric estimation of a demand system was possible (see appendix C). In the absence of such information, the structure of demand must be inferred in indirect and imprecise ways. Even with statistical estimates, the parameters used are subject to uncertainty, if only from sampling error of the estimation procedure. Therefore, it is important to understand the implications of a particular set of parameters and how much the results are likely to differ with this choice.

In general, the less elastically the commodities in question are demanded: a) the smaller will be the deficit reduction associated with a given subsidy reduction to the rural sector b) the greater will be the offset to rural real income reduction due to reductions in the urban cost of living, c) the larger will be the deficit reduction due to urban price increases and d) the larger will be the loss to urban consumers as a result of price increases. Changing the assumptions concerning demand, then, increases the attractiveness of each of these policies in some ways, and reduces it in others.

Less elastic demand makes the deficit more stubborn in the face of rural price changes since the government deficit is sensitive to the marketed

surplus from the rural sector. If the total marketed surplus is very sensitive to price, then a small reduction in price will reduce the amount sold through government channels significantly. To achieve the same deficit reduction in an inelastic demand regime, larger price reductions will be necessary.

By the same token, the less elastic is the demand structure, the more a given reduction in price will reduce the cost of living for the residents of rural areas. Inelastic demands indicate that alternative goods are not available or are not used to a great extent. Therefore price increases for those goods are fully borne by the consumer. Conversely, when the price is reduced, this comes as a relief to the consumer. For the analysis of the effects of reducing the rural price of basic grains in Korea, the use of inelastic demands implies the need for large decreases in price to relieve the deficit (relative to a more elastic demand case) and larger decreases in the nominal income of farmers. Countering this effect is the larger reduction in the cost of living (in the rural sector and in the urban sector due to the price reduction of traditional rice).

In the urban sector, in contrast, the more inelastic the demand for grains, the easier it is to reduce the deficit with a given increase in price. In rice, one offset to the deficit was the ability to earn tariff revenue on imports. If demand, for rice is elastic, an increase in price reduces demand, imports and tariff revenue substantially. If inelastic, the gap between rural and urban prices can be closed without creating as much loss in revenue. At the same time, however, this resistance of the quantity demanded to price makes the goal of self-sufficiency harder to achieve through price increases. Decreases in demand are reflected first in import reduction. If demands do not respond very much to price, neither will imports

or the self-sufficiency ratio. Similarly, if rural prices are decreased, inelastic demand in the urban sector will mitigate the effect on self-sufficiency. In general, inelastic demand makes self sufficiency less of an issue. It is not sacrificed as much with rural price declines and it is not promoted as much with urban price increases.

When the demand system is inelastic, the cost of living in the city is increased more when the release price is raised. Therefore, the impact of this policy on the calculation of real disposable income for the country as a whole is exacerbated.

The effect of cross elasticities have been discussed above (Multi-market interventions) and were seen to be of importance to the analysis of "spillover" effects of policies aimed at one market on the deficit generated in another market. Cross-elasticities are usually very hard to estimate accurately in practice. For Korea, the intermarket effects were due to a number of influences besides the cross price elasticity effect in the demand system. The principal effect of cross price terms was to create a link between the structure of urban demand and crop patterns in the rural sector. With no cross price effects, the relative use of land between high yield and traditional vice was independent of urban prices. With direct substitution between the two rice, an increase in high yield prices in the urban sector will increase overall demand for traditional rice and production will shift toward traditional rice. Therefore, there is a secondary effect of this policy on deficits in the rice markets: Reduced supply and marketed surplus of high yield rice leads to further reduction in the rice deficit.

These comparisons have been made between two very different demand systems. The system embodied in the "B" model assumes very elastic demand. The own price elasticities for all foods is -1 and the direct cross price

effects are zero. The "A" system, using estimated parameters, had implied own price elasticities of -.3 for barley and -.5 for rice by people earning the mean rural income. These are significantly different and give rise to the very different outcomes outlined above. It is important, therefore, to have a fairly good notion of the "true" behavior of the consumers. Fortunately, while the results change significantly with the relatively large differences between the two models, small variations around the parameters in version A do not significantly change the results. Therefore, a reasonably good guess at the actual elasticities is probably sufficient to get meaningful results.

IV.3 Supply Parameters

Two issues arise in the discussion of model specification on the supply side. First, as with demand, the effect of changing the parameter estimates used in the simulations may be explored. More importantly, the assumptions concerning crop substitution possibilities and equilibrium allocations of land should be subject to examination.

The production structure used in the presented versions of the model are based on the Cobb-Douglas production structure and its related restricted profit function. Econometric estimation was carried out for the more general production structure based on the translog restricted profit function. Results of this estimation are presented in Appendix C. While the formal test of the Cobb-Douglas form was rejected, the actual parameter estimates derived from that exercise were similar to the Cobb-Douglas specification derived from aggregate production statistics. When the simulation was run using the estimated values for production, very little was changed from the results presented in version B. The only effect was to reduce the supply response to a small degree. Given the much greater data requirements of the translog

functional form, the Cobb-Douglas version is most likely to be useful in further applications of the model.

The more important issue concerning the specification of production involves the assumption of identical production functions for high yield variety rice and traditional rice and its implications for equilibrium in the rice markets and in land use.

Since there was no independent information concerning the production structure of the two types of rice (production parameters were computed for the aggregate commodity of total rice), the profit functions were assumed to be identical except for a shift parameter for high yield which was chosen to conform to known differences in yield between the two types of rice. In conjunction with the assumption that land would be allocated between the two strains of rice until their marginal value products were equal, this assumption led to a linear production possibility frontier between the two types and substantial substitution possibilities between them. If the two types of rice have entirely different production functions, the substitutability would be reduced. The consequences of relaxing the assumption of identical production functions are relatively minor. Given that the two rices are, in fact grown on the same kind of land in the same season, the formal modelling of land allocation make sense. A production possibility frontier between two such commodities will be approximately linear unless their production processes are very different. 23/ Somewhat more fertilizer or less labor in one or the other is not likely to make much difference. To the extent that it does, however, the consequences of less substitution is to make the supply response of high yield rice more inelastic (thereby reducing the

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23/ See Harry Johnson, Aspects of the Theory of Tariffs.

effectiveness of small rural price reductions in removing the deficit) but will also make farm incomes somewhat less sensitive to the subsidy as well. The reason for the latter point is that with less substitution possible, the reduction in the subsidy rate will lead to smaller increases in the output of traditional rice and therefore, smaller reductions in the price. The farmer is protected from lost revenue in the other main crop. Again, the probable impact on this change of assumption is small.

IV.4 Rural Labor Market

The most important ways in which the various models differ from one another are not in differences in parameter values assumed within the model structure but in the choice of model structure itself. The two most significant aspects of the model in which alternative assumptions lead to very different conclusions are in the market structure assumed to hold for rural labor and in the detailed disaggregation of income classes in both the rural and urban sectors.

The two polar assumptions made in the simulations are that wages in the rural sector are fixed (version B) and that wages are flexible but the total supply of labor in the rural sector is fixed (version A). In the latter case, the wage will fall if the demand for labor is reduced due to lower grain prices. In other words, we have assumed that rural labor supply is perfectly elastic and perfectly inelastic respectively.

The difference between these two assumptions is most apparent in the evaluation of the responsiveness of rural incomes to support price changes and in the identification of gainers and losers in that case. When wages are fixed, the effect on rural incomes is moderated greatly. The income of most people is derived in large part from their own labor. If this labor retains its value when support prices are reduced, total incomes will not change very

much. This is especially true of "full" income which values leisure time at its opportunity cost, or the wage rate. Thus, a 10 percent reduction of the price of rice leads to a 2.5 percent fall in average rural incomes in the fixed wage case but results in a 9.5 percent fall when wages are allowed to vary.

Perhaps more interesting than the change in the average level of income in the rural sector is the different distributional implications of the two versions of the model. In the fixed wage case, the rural sector does not uniformly suffer from a reduction in the farm subsidy. Landless workers and the very small farmers (together making up about 30 percent of the rural population) actually benefit from rural price reductions. The landless get no benefit from the subsidy either directly (since they own no land) or indirectly (through increased demand and, therefore, increased return for their services). The higher prices for basic grains merely increases their cost of living. Indeed, they seem to be the biggest gainers from a cut in the subsidy. Small farmers, who are also net purchasers of grain, also get a benefit from a price fall though smaller than that for the landless since they purchase a smaller percentage of their consumption of grains. In the fixed wage case there is a conflict of interests between the small and large farmers.

In the flexible wage case, these differences between residents in the rural area disappear. One consequence of a grain price reduction in this case is a lessened demand for labor. This translates into a lower wage which affect all workers in farming, not just the landowners. A flexible wage brings about a unification of interests, through the labor market mechanism, the costs of the lower support price are shared by the whole sector.

Which of these assumptions is true is difficult to determine. In the very short run (when grains have already been planted say) the fixed wage case is most relevant. If there are many employment opportunities in the rural sector outside of rice and barley production which may have very elastic demand for labor, this would also lend support for a fixed wage. However, for a planning period of a crop season (when plans for hiring or allocating labor can be altered) and, as is the case, rice and barley are the main rural activities, there will be some wage adjustment. It will probably not be as severe as version A suggests, however, as there is likely to be at least some elasticity of supply of labor, even in the short run. In the long run (which this model is not completely equipped to analyze) the wage responsiveness of labor is probably fairly high as the reduced wages induce migration to the urban areas. In this case, as mentioned above, the fixed wage case is probably closest to the truth and the induced migration is given by the total reduction in demand for labor.

A secondary effect of allowing for rural wage determination is that the implied supply elasticities are reduced. If wages fall due to decreased labor demand, per unit costs of production of grain fall as well. This provides a partial, though necessarily incomplete, offset to the reduced profits of farming and moderates the fall in production.

IV.5 Intrasectoral Income Distributions

The second main aspect of the model which would change the results under alternative formulations is the treatment of the intrasectoral income distribution.

Few of the descriptive results change with the disaggregated modelling of the income distribution. That is, total supply response is

unchanged and the change in demand elasticities is negligible. What does change is the normative assessment of alternative policies.

One standard approach taken in project evaluation is to aggregate the rural sector into one group and the urban sector into another. In Korea, the rural sector would be the poorer sector on average. Therefore, all evaluation based on increasing the governments concern for the poor would give a premium to any policy favoring the rural sector. As discussed above, when the income distribution is characterized in more detail, it becomes clear that the very poorest segment of the population are urban dwellers. This apparent contradiction is resolved by noting that the urban sector distribution of income is far more inequitable than is the rural. Further, in our definition of classes, this groups is 15 percent of the population as opposed to 28 percent in the entire rural sector and is, therefore, a substantial counter argument to the simpler characterization. Therefore, there is no simple way to summarize the effect of concern for income distribution on evaluation of policy. It is still true that the rural sector is generally poorer than the urban but concern for the very poor might lead to an urban bias in choosing policies. Therefore, it is important for the policy maker to be explicit as to what aspects of the income distribution are most in need of improvement, its overall shape (leading to favoring rural areas) or its lower tail.

Within the rural sector the disaggregation into smaller classes also changes the interpretation of some of the results. As discussed in the previous section, when the rural wage is fixed, there is disagreement as to the attractiveness of reducing rural prices within the rural sector itself. While the sector as a whole is damaged by the subsidy reduction, the poorer groups within the sector are the greatest beneficiaries of the subsidy reduction since they are net consumers of the now cheaper grain. By

identifying the interests of the sector, as a whole, with those of the poor we run the risk of ignoring the poor in the rural sector.

The net result of aggregation into rural and urban sectors and treating them as different income groups leads to the result of giving preference to the 16th to 43rd percentile groups in the population when the rural poor share the average rural income change or the 23rd to 43rd percentile groups when they do not. It is not clear what ethical system would lead to this pattern of preferences.

Chapter V

Conclusion

The Government of Korea must decide the relative important of its various agricultural policy goals such as self-sufficiency and maintenance of farm incomes. It must also decide what costs are acceptable in attempting to achieve these goals, costs which will arise in the form of changes in government deficits, of adjustments in the urban cost of living, and of shifts in the income of the very poor, who are urban residents. Agricultural policy, especially pricing policy, may well advance one of these objectives but incur costs which are too high or which have offsetting negative effects on other agricultural policy goals.

The conclusions emerging from our analysis are classified into three categories: (a) detailed pricing policy conclusions, (b) methodological conclusions, and (c) overall agricultural policy conclusions.

V. 1 Pricing Policy Conclusions

(a) Rice. The rice market best illustrates the conflict between the various goals of government policy. The consequences of rice pricing policies which are on the immediate agenda are exemplified by the following:

(i) For a 10% reduction in the rural prices of high yield rice

- the combined GMF and FF deficit will decline by 32%
- national income will increase by .13%
- average rural incomes will decline by 5.5%
- the proportion of rice consumption met by local production will fall from 93% to 88%

(ii) For a 10% increase in the urban price of high yield rice

- the combined GMF and FF deficits will decline by 20%
- national income will decline by .44%
- average urban incomes will decline by .65%
- the proportion of rice consumption met by local production will increase from 93% to 94%

(iii) In general, the deficit is more sensitive to changes in rural than in urban prices

(iv) If the government is constrained to the use of rice prices, the goals of self sufficiency and rural income conflict directly with national income and the cost of living. The order of magnitudes are provided above and in greater detail in the text.

(b) Barley. National consumption of barley is unlikely to be increased by pricing policies alone. Current policies encourage severe overproduction leading to large inventories which are wasted. The impact of lowered support prices on income is modest (though certain regions may be disproportionately affected). If consumption for nutritional reasons is the goal, reliance on cheap imports is a more effective means.

(c) Fertilizer. Current fertilizer prices serve as a direct tax on the farmer. The ability to obtain low-cost fertilizer from world markets or from a domestic industry which is competitive with those markets would increase farm income by a half percent. In addition, substantial deficit costs could be saved. If price reductions for rural crops are implemented, fertilizer price reductions could offset some of the added burden on the farmer.

(d) Policy Coordination. Price policies for rice and barley must be considered simultaneously. Due to substitution possibilities in supply and demand, intervention in one commodity market has important consequences for

the other. If one rural price is to be lowered, the other should be lowered as well in order to limit the increase in its marketed surplus. Urban prices may be treated more independently because the spillover effects are of a complementary nature.

V.2 Methodological Considerations

The method of analysis used in this report raises two issues.

a) Multi-Market Analysis

Substitution possibilities in both production and consumption are frequently overlooked in standard analyses. These are of central importance to the results reported here. For producers, the ability to substitute traditional rice for high yield variety rice leads to considerably higher supply elasticities for the subsidized commodity than would emerge from an analysis of the aggregate commodity "rice". This has profound effects on the calculation of deficit reductions due to price changes. It also helps to identify indirect effects of policies, such as the reduced cost of traditional rice in urban areas when the rural high yield price declines.

On the demand side, the spillover effects of related markets are substantial. When rural rice prices are reduced, for example, barley sales to the government increase, partially offsetting the savings in the deficits. Consideration of such multi-market effects leads to substantive policy implications, such as the need to coordinate price changes in related commodities. Such effects require a general approach to modelling the rural sector.

b) Sensitivity of Results

In any numerical exercise of this kind, some concern always surrounds the reliability or the robustness of the results. Exact predictions of the effects of possible policies require exact knowledge of the values of the

underlying parameters. This knowledge does not generally exist. Some parameters, such as cross price elasticities, are notably difficult to identify with precision. Encouraging for this report is the fact that the essential story of the price policy effects is unchanged in various alternative formulations and parameter values. The qualitative effects of policies are resistant to reasonable changes in parameter values. The quantitative effects vary, of course, but within bounds narrow enough to be useful.

V. 3 Agricultural Policy and the Goals of Government

Each of the goals mentioned above is of genuine value for Korean society. The difficulty, and the need to evaluate tradeoffs, arises from the fact that all of these goals cannot be satisfied by changes in agricultural prices alone. Too many different effects are expected from the application of these limited tools. Instead, priority should be given to expanding the number of policy instruments available in order to allow the government to satisfy more of its objectives simultaneously.

One important purpose of the GMF was to improve the standard of living in the rural sector in order to moderate the rapid migration into already congested urban areas. If it is migration which is the problem, then solutions should be found which attack it directly. Off farm employment possibilities, decentralization of industry, urban amenities and planning, rural social services and agricultural extension might be encouraged rather than putting undue emphasis on agricultural pricing policies.

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APPENDIX A

A Background Note on the Grain Management Fund (GMF) and Fertilizer Fund (FF) in Korea

Since the early 1960's the Grain Management Fund (GMF) and Fertilizer Fund (FF) have been the central elements of a system of dual agricultural pricing in Korea. The two marketing boards have had a substantial impact on the market for food grains and fertilizers, and have incurred a significant proportion of the total government deficit. This note discusses essential features of the public pricing and distribution system, particularly for rice, barley, and fertilizer, and touches upon related institutional aspects which are relevant to the model.

I. Grain Management Fund (GMF)

I.1. Economic Importance of Rice and Barley.

Rice and barley have traditionally been the most important crops in the Korean agricultural economy. In 1981, rice accounted for 52 percent of agricultural receipts, and about 8 percent of GNP.[1/] The relative share of

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1/ For the relative composition by crop of agricultural gross receipts, see Report on the Results of Farm Household Economic Survey, MAF, 1982, p. 62. According to the report, average gross receipts from rice per household amounted to 1,697,088 won in 1981. Multiplying the average receipts from rice

barley has declined in recent years, from about 10 to about 4 percent of agricultural gross receipts.

Consumer expenditure on rice is substantial as well. Expenditure on rice was 12 percent of total urban household expenditure in 1979, and 19 percent of total farm household expenditure in 1981.2/ In these years, expenditure on barley was .3 percent of urban and 2 percent of rural household expenditure, respectively.

I.2. Operations and Objectives of GMF

Since the enactment of the Grain Management Fund Law in 1950, the markets for rice and barley have been subject to substantial government intervention.3/ The government has had the following primary objectives: a) to provide adequate production incentives for farmers, in order to obtain self-sufficiency in the major grains, and to raise farm incomes; b) to hold down consumer prices in urban areas; and c) to stabilize the prices of rice and barley, especially in the immediate post and pre-harvest seasons.

The government authority extends to complete price and quantity regulation of the domestic and import/export grain markets; and also to directly procure, transport, store, mill, and sell government controlled grains. In practice the grain markets operate as a dual system of free and government controlled markets, with varying degrees of intervention from year to year (Table 1).

by the total number of farm households, 2,030,000 gives us national gross receipts from rice to derive the percentage contribution to GNP.

2/ Computed from Annual Report on the Family Income and Expenditure Survey, Economic Planning Board, 1978, and "Report on the Results of Farm Household Economy Survey," MAF, 1982.

3/ For the historical development of both rice price and government intervention, see Moon, Pal Yong, "The Evolution of Rice Policy in Korea," Food Research Institute Studies, Vol. XIV, No. 4, 1975, Stanford University.

Table 1: Quantities of Domestic Production and Government Purchasing of Rice and Barley

(Unit = 1,000 Seok)

Year	Rice (Polished)			Barley (Polished)		
	Production (A)	Gov't. Purchase (B)	B/A	Production (A)	Gov't. Purchase (B)	B/A (%)
1965	24,313	2,097	8.6	10,575	552	5.2
1968	22,189	919	4.1	12,171	817	6.7
1970	27,356	2,436	8.9	11,528	1,294	11.2
1973	29,248	3,331	11.4	10.461	2,669	25.5
1975	32,429	5,483	16.9	10,062	2,994	29.8
1976	36,215	7,245	20.0	12,780	4,138	32.4
1977	41,706	9,742	23.4	5,896	1,372	23.3
1978	40,258	9,413	23.4	9,768	3,504	35.9
1979	38,645	9,032	23.4	10,929	4,056	37.1
1980	24,655	3,790	15.4	5,876	2,996	51.0
1981	35,160	6,167	17.5	6,221	2,948	47.4

Note: Polished Rice 1 Seok = 144 kg
Polished Barley 1 Seok = 138 kg

Source: Agricultural Policy Handbook, MAF, 1982, p. 204.

I.3. Total GMF Deficit

The GMF deficit has been a substantial proportion of total government expenditures, from .3 percent to 10 percent over the years 1970-1981 (Table 2). Management of the deficit has become a major component of money supply management, since this deficit has been directly financed through loans from Bank of Korea.

The deficit is incurred as follows: the government purchases substantial stocks of grain in the harvest season, to support the producer price, and releases stocks at a lower price in the off-harvest season. The wedge between purchase and release price became substantial in the early 70's (Table 3). Note that both the purchase and release prices are well above the world price for rice; the purchase price has in fact been more than double the world price in recent years. Handling costs are a substantial proportion of the deficit. In 1980 the handling cost per bag of rice was 60 percent of the direct loss per bag. Handling costs and direct loss per bag of barley are even higher than for rice.

II. Historical Overview of Food Grains

II.1. Production of Rice and Barley

Table 4 presents a summary of the production history of rice and barley in recent years. Rice production increased steadily from 1970 until 1977, when Korea produced a record crop of about one and one-half times the 1970 harvest. The introduction of high yielding varieties (HYV) of rice, increased application of fertilizers; a steady development of the rural infrastructure contributed to an increase in productivity, and the area sown increased slightly. After 1977, Korea experienced a modest decline in rice production for two years, followed by a drastic decrease in 1980, a year which witnessed bad weather and disease.

Table 2: Grain Management Fund Deficit by Crop

(Unit = 100 Million Won)

Year	Rice (A)	A/C (%)	Barley (B)	B/C (%)	Misc. Grains	Wheat Subsidy	Total (C)	Central Gov't Expenditure & Net Loan (D)	GNP (E) (Current Prices: one billion won)	C/D (%)	C/E (%)
1970	4	- 28		- 4		- 28	-		2,684		
1971	51		- 45		- 6		5,485	0	3,295		
1972	49		- 61		- 4	6	- 22	7,462	4,029	0.30	
1973	9		- 88		- 10	- 165	- 254	7,212	5,238	3.52	0.485
1974	- 327	26.2	- 356	28.5	- 19	- 548	- 1,250	12,030	7,333	10.39	1.705
1975	- 163	17.4	- 220	23.5	- 7	- 546	- 936	17,653	9,793	5.30	0.956
1976	- 197	39.1	- 286	56.9	- 5	- 15	- 503	25,189	13,273	2.00	0.379
1977	- 219	34.7	- 433	68.6	21	0	- 631	32,744	17,021	1.93	0.371
1978	-1,540	96.8	- 145	9.1	94	0	- 1,591	44,080	22,918	3.61	0.694
1979	-1,851	88.7	- 285	13.7	49	0	- 2,087	59,990	29,072	3.48	0.718
1980	-1,400	57.9	-1,068	44.2	51	0	- 2,417	76,820	34,322	3.15	0.704
1981	- 218	15.1	-1,268	88.0	45	0	- 1,441	-	42,397	-	0.340
Total	-5,802	52.0	-4,283	38.4	205	-1,280	-11,160	-		-	

Note: Negative numbers indicate loss in the Government Grain Management operations.

Source: Food Bureau, MAF, 1982.
Government Expenditure data are from Public Finance and Banking Statistics, Ministry of Finance, November, 1981.

Table 3: Grain Management Fund Deficit by Rice and Barley per Bag
(Unit : Won)

Rice Year	Rice (Polished 80 kg = one bag)					Barley (Polished 76.5 kg = one bag)			
	Cost			Revenue	Deficit	Cost		Revenue	Deficit
	Purchase Price (a)	Handling Cost (b)	Import. Price	Release Price (c)	(c)-(A+B)	Purchase Price (a)	Handling Cost (b)	Release Price (c)	(c)-(A+B)
70	5,150	578	4,788	5,400	- 328	3,348	439	2,750	- 1,037
71	7,000	664	4,449	6,500	- 1,164	3,580	548	3,100	- 1,298
72	8,750	738	4,372	9,500	12	4,890	572	4,300	- 1,262
73	9,888	792	7,982	9,500	- 1,180	6,357	796	4,800	- 2,353
74	11,377	915	16,495	11,264	- 1,028	6,993	909	6,000	- 1,902
75	15,760	1,488	15,643	13,000	- 4,248	9,091	1,412	6,900	- 3,603
76	19,000	1,996	10,183	16,730	- 4,766	11,100	1,446	8,320	- 4,226
77	23,200	2,424	8,480	19,500	- 6,124	13,000	1,749	9,200	- 5,549
78	26,000	3,372	no import	22,420	- 7,212	15,500	2,462	10,120	- 7,842
79	30,000	5,088	11,113	26,500	- 8,588	18,500	4,062	10,120	-12,448
80	36,600	7,126	21,645	32,000	-11,960	22,000	9,618	10,120	-21,498
81	47,750	9,750	N.A.	44,000	-11,500	26,400	12,546	17,595	-21,351
82	52,100	10,184	N.A.	53,280	- 9,064	29,700	13,691	19,355	-24,036

Note: Rice year begins November 1 of previous year and ends October 31, current year. (Rice deficit calculations exclude tariff revenues).

Source: Agricultural policy handbook, MAF, 1982, p. 206.
Import prices in US Dollar are from Kym Anderson "South Korean Agricultural Price and Trade Policies: Their Effects since 1965" Working Paper, KREI, March 1981.
The price series in dollars are converted into Won using annual exchange rate.

In contrast, the planted area for barley decreased by about 57 percent over the decade, falling sharply in the later years. Barley production declined by half during the period due to the reduction in the relative profitablity of barley, as well as decreased per capita consumption. For all other field crops but vegetables, planted area decreased over the decade (Table 5). These crops maintained nearly constant yeilds per acre, in contrast with rice and barley, leading to a decline in their relative profitability. However, the area sown to vegetables increased substantially in the late 1970's, as the demand for vegetables increased. The demand, though, seems to be saturated and the increased supplies of last year led to significant reductions in prices and profitability. The production of livestock also increased substantially during the 70's.

II.2. Consumption of Rice and Barley

The 70's have seen significant changes in food consumption patterns in Korea. Grain consumption per capita has declined slightly since 1970, and that of vegetables, meats and fruits has substantially increased (Table 3).

Per capita consumption of rice,the most important cereal in the Korean diet, has been more or less steady over the decade, with a slight drop in the middle years. (Transmitting changes in rice consumption per capita may be done more to supply constraints rather than income effects.) Average consumption was about 130 kg per capita.

Barley consumption has dropped sharply, especially from 1977. Over the decade, per capita barley consumption decreased by 63 percent, from 37 kg in 1970 to 14 kg in 1980.

Two factors account for the fall in barley consumption: rising incomes, as barley has traditionally been an inferior good; and the removal of government regulations imposed to encourage barley consumption in the early

Table 4: Production and Planted Area for Rice and Barley

	Rice			Barley		
	Production (1,000 M/T)	Planted Area (1000 ha)	Yield kg/hd	Prodn (1000 M/T)	Planted Area (1000 ha)	yield kg/ha
1965	3,501	1,228	2,851	1,657	933	1,776
1970	3,939	1,203	3,274	1,820	833	2,185
1971	3,998	1,190	3,360	1,715	768	2,233
1972	3,957	1,191	3,322	1,756	777	2,260
1973	4,212	1,181	3,566	1,549	713	2,173
1974	4,445	1,204	3,692	1,468	745	1,970
1975	4,669	1,218	3,833	1,806	760	2,376
1976	5,215	1,215	4,292	1,847	752	2,456
1977	6,006	1,230	4,883	862	545	1,582
1978	5,797	1,229	4,717	1,388	575	2,414
1979	5,565	1,233	4,513	1,556	489	3,182
1980	3,550	1,233	2,879	906	360	2,517
1981	5,063			858		

Source: Yearbook of Agriculture and Forestry Statistics, MAF, 1981 p. 62 and p.66. Yields are computed from production and planted area.

Table 5: Planted Area of other Crops, Vegetables and Fruits

(Unit: 1,000 ha)

Year	Miscell Grains	Pulses	Potatoes	Vegetables	Special Crops	Total Land* Utilized
1971	99.6	337.8	163.3	257.1	90.6	3,100.3
1972	85.5	340.1	147.4	247.9	81.7	3,076,1
1973	91.6	369.7	138.2	254.2	83.3	3,048.9
1974	72.8	333.4	121.5	274.1	107.0	3,096.5
1975	73.4	332.7	146.3	243.5	108.9	3,143.6
1976	66.6	312.4	136.1	281.4	123.6	3,173.6
1977	64.9	326.5	127.3	293.9	121.6	3,033.2
1978	54.9	313.8	112.6	275.7	121.7	3,001.1
1979	49.3	276.8	94.8	338.7	118.9	2,908.6
1980	52.7	255.5	92.4	359.3	105.8	2,765.2

* Total land utilized includes double cropped and means national total area devoted entire agricultural field crops.

Source: Yearbook of Agriculture and Forestry Statistics, MAF, 1981, p. 32.

Table 6: Trend of Per Capita Yearly Food Consumption

(Unit: kg)

Year	Rice	Barley	Wheat	Vegetables	Meats	Fruits	Per Capita GNP (current US$)
1965	121.8	36.8	13.8	46.7	4.6	9.8	105
1970	136.4	37.3	26.1	59.9	6.6	10.0	243
1975	123.6	36.3	29.5	62.5	6.5	14.0	574
1976	120.1	34.7	30.2	68.2	6.9	13.1	765
1977	126.4	28.5	30.3	62.5	7.8	15.3	965
1978	134.7	18.1	30.5	104.0	10.1	16.2	1,279
1979	135.6	14.1	30.6	122.5	11.4	16.4	1,597
1980	132.4	13.8	29.4	120.6	11.3	16.2	1,481
70/80	97.1	37.0	112.6	201.3	171.2	162.0	

Note: Meats include beef, pork and chicken.

Source: "A Study on the Demand Supply for Food," Research Report #32, Korea Rural Economic Institute, December 1981, p. 5.

years of the decade. Restaurants had been required to serve a mixture of three-quarters rice, one quarter barley; to serve riceless dishes twice weekly, and to use a smaller, standard sized bowl. The government prohibited making alcohol from rice. In 1977, in the face of a record rice crop, most of these restrictions were removed. Per capita barley consumption dropped in the next year by 36 percent, and rice consumption increased by 6 percent.

As per capita income grows, barley consumption is likely to decline even further. On the other hand, demand for barley as animal feed and in beer production is expected to increase.

II.3. Imports of Rice and Barley

Grain imports between 1956 and 1964 were carried out under U.S. Public Law 480, after Korea signed the U.S. Farm Surplus Importation Agreement in 1955.4/ Farm products imported under the agreement, which allowed virtually free imports, include wheat, barley, and other commodities, but exclude rice. Wheat and barley accounted for roughly 50 to 60 percent of the annual value of these imports. During this period, Korea imported about 13 percent of total domestic production, and of this, some 84 percent were grain imports under US PL480. Although the import of free grain on this scale helped to ease foreign exchange constraints, there is still disagreement among researchers about the effect of PL 480 on Korea's long term agricultural development.

Table 7 displays production, consumption, and import statistics for rice and barley from 1965. Other sources of demand are animal feed, waste, and

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4/ For an historical perspective on grain imports and rice policy in Korea, see Moon, Pal Yong "The Evolution of Rice Policy in Korea," Food Research Institute Studies, Vol. XIV, No. 4, 1975, Stanford University.

Table 7: Production, Human Consumption, and Imports of Rice and Barley

(Unit : 1,000 M/T)

	Rice			Barley		
Year	Prodn	Human Consump	Import	Prodn	Human Consump	Imports
1965	3,501	3,496	-	1,657	1,056	7
1970	3,939	4,275	541	1,820	1,169	-
1971	3,998	4,433	907	1,715	1,210	-
1972	3,957	4,506	584	1,756	1,256	254
1973	4,212	4,413	437	1,549	1,340	350
1974	4,945	4,434	206	1,468	1,384	299
1975	4,669	4,361	481	1,806	1,281	354
1976	5,215	4,307	157	1,847	1,244	-
1977	6,006	4,606	-	862	1,038	330
1978	5,797	4,986	-	1,388	670	-
1979	5,565	5,099	502	1,556	530	-
1980	3,550	5,048	580	906	526	-
1981	5,063	-	-	-	-	-

Note: 1) Measured in polished grains
2) Human Consumption figures are obtained by per capita consumption multiplical by the total number of population.

Sources: Yearbook of Agriculture and Forestry Statistics, MAF, 1981, p. 62.
Handbook of Agricultural Policy, MAF, 1982, pp. 30, 193 and 200.

government inventory, which are not shown. Substantial shortfall in production has resulted in imports for both rice and barley; in 1971, for example, rice imports accounted for 20 percent of domestic consumption. Barley imports were substantial during the mid-70's, although there have been no imports since 1978. Imports of rice and barley are handled directly by the government, whereas the imports of wheat and other grains are handled partially by private importers.

III. The Rice Market

III.1. Production of Rice by Variety

Table 8 presents the production history of rice, broken down by high yield and traditional varieties. The high-yield variety of rice, Tongil[5/], was introduced on a large scale in 1974. At the peak of its success in 1977, average productivity had risen by 46 percent over 1971; Tongil yeilds were 1.3 times those of traditional varieties.

Acreage sown to HYV increased rapidly in 1978. Currently, the choice of variety to plant rests entirely with the farmer, but in the early years of the decade he was encouraged by several government policies. An educational campaign was carried out through the Office of Rural Development, which explained the new production techniques and encouraged use of the new varieties. Easy access to subsidized agricultural credit was provided to those farmers who planted HYV rice. However, the most important instrument to influence farmers' choice of rice variety was the government price support for HYV. Government procured large amounts of HYV, and from the mid-70's the

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5/ Tongil is a cross-breed of the Indica and Japonica rice which requires more intensive application of chemical fertilizers than do traditional varieties. It matures early and has shorter shares than traditional rice strains, as well as a high yield potential.

Table 8: Area Planted and Yields by Rice Variety

Year	Area Planted (1,000 ha)			Yield (kg/ha)			
	H.Y.V.	T.V. 1/	Total	H.Y.V.	T.V.	Average	A/B
1971	3(0.3)	1,175(99.7)	1,178	5,010	3,370	3,370	148.7
1974	181(15.2)	1,008(84.8)	1,189	4,730	3,530	3,710	134.0
1975	274(22.9)	924(77.1)	1,198	5,030	3,510	3,860	143.3
1976	533(44.6)	663(55.4)	1,196	4,790	3,960	4,330	121.0
1977	660(54.6)	548(45.4)	1,208	5,530	4,230	4,940	130.7
1978	929(76.2)	290(23.80	1,219	4,860	4,350	4,740	111.7
1979	744(60.7)	480(39.3)	1,224	4,630	4,370	4,530	105.9
1980	604(49.5)	616(50.5)	1,220	2,870	2,920	2,890	107.1

Note: 1/ Traditional Variety
2/ The members in the parenthesis indicate relative percentage.

Source: Yearbook of Agriculture and Forestry Statistics, MAF, various years.

amount of traditional rice purchased by the Government was negligable (see Annex Table 4). Incentives were concentrated in those regions most suited to the new high yield varieties. From its peak in 1978, when three quarters of acreage sown was to HYV, HYV production has declined sharply. Two factors account for this: the high risk of HYV; and increasing yields of traditional rice. Traditional variety rice has shown a strong increase in productivity over the decade; yield ratios of the two varieties have dropped from 1.5 at the beginning of the decade to nearly one. As the free market price of traditional rice is higher than that of HYV, traditional rice has become relatively more profitable.

1980 was a disastrous year for the rice crop in Korea, and highlights the increased risk of HYV rice. Unusually cold weather during the growing season encouraged the spread of disease to which Tongil rice is quite susceptible. Average yields fell to the lowest in the decade, and HYV yield was below that of traditional rice.

III.2. Marketing Rice

As the Government procures and markets only part of the rice crop each year, there are broadly two channels by which rice is marketed in Korea: an unregulated free market, and the government channel. There are also broadly two products in each market: traditional variety rice, which is much preferred by the Korean consumer, and commands a premium in the free market; and HYV rice.

Table 4 in the Annex gives government purchase quantities of rice by variety; Table 9 gathers together production, consumption, and marketing statistics for several years. Two features stand out from this data: the government has purchased virtually only HYV rice for several years, although it purchased slightly more traditional rice in 1981. Total government

Table 9: PRODUCTION, MARKETED SURPLUS, GOVERNMENT TRANSACTION OF RICE IN KOREA

Rice Year	Total Production 1/	Quantity of T.V. Produced 1/	Quantity of HYV Produced 1/ 2/	Marketed Surplus of aggregated Rice 2/	Quantity Purchased by Gov't.	Quantity Released by Gov't.	Quantity Consumed by Non-Farm Household
1965	24,313	N.A.	N.A.	N.N.	2,097	652	11,271
1970	27,356	N.A.	N.A.	12,198	2,436	5,199	18,148
1975	32,134	22,553	9,581 (29.8)	15,612	5,483	3,838	18,262
1976	35,969	18,236	17,733 (49.3)	17,438 (54.3)	7,245	5,890	18,421
1977	41,425	16,091	25,334 (61.2)	20,081 (55.8)	9,742	4,210	20,260
1978	40,133	8,770	31,363 (78.1)	22,506 (54.3)	9,413	8,215	22,726
1979	38,515	14,567	23,948 (62.2)	21,889 (54.5)	9,032	11,686	23,859
1980	24,511	12,477	12,034 (49.1)	N.A.	3,790	12,099	23,787
1981	34,997	25,251	9,746 (27.8)	N.A.	6,167	10,832	25,094

N.A. Neither available nor exist.

Note:

1/ Figures related to production are measured in Calendar Year but the rest of figure are in rice year. Rice here includes only paddy rice, excluding upland rice which is about 3 to 5 percent of total rice production.

2/ The numbers in the parentheses with the quantity of H.Y.V. produced are percentage of corresponding year's total production but those with marketed surplus of aggregated rice are percentage of previous year's total production.

Source:
- Production figures from Ag. Policy Handbook, MAF 1982, p. 126.
- The rest of data up to 1979 from "A Study of Rice Marketing (in Korea)" Joo Yong Jae, et. al., Korea Rural Economics Institute, Research Report No. 21, 1980, December p. 96-97.
- The data for 1980, 1981 from Agricultural Policy Handbook 1982 and by derivations.

purchases have been much less than those required to satisfy urban consumer demand, indicating that substantial quantities of both HYV and traditional rice flow through private markets.

Precise data on the kinds of rice that flow through private markets is unavailable, but quantities are inferred as follows: Based upon a rice marketing survey conducted in 1978 by the National Agricultural Cooperative Federation, we assume that the average urban household consumes 70 percent of HYV and 30 percent traditional rice.6/ Consumption figures may then be calculated from aggregate rice statistics (Table 10). Urban demand is met partly by government rice, for which detailed statistics exist; any excess demand is assumed to be met through private markets. Using these figures for 1979, 31 percent of HYV rice consumed by urban households was supplied through the private market (Table 11).

We assume for simplicity of modeling, however, that HYV rice is handled only through government channels. This assumption is more applicable to current years since the rapid drop in production quantities of HYV rice in recent years (by roughly a factor of 2 from 1979 to 1980) makes it unlikely that there was a large active private market in HYV rice in 1980 and 1981. This is supported by the evidence of purchases of traditional variety rice by the GMF in 1981.

The government releases its rice at a uniform price throughout the year, with the objective of stabilizing consumer prices. Annex Table 12 gives the monthly price profile of free market rice. There is a variation of approximately 20 percent over the year; generally the peak price occurs in the

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6/ Corresponding figures for rural households are 84 percent HYV and 16 percent traditional.

Table 10: Flow of Rice Among Sectors in Rice Year 1979

(Unit : polished 1000 M/T)

Farm Households

o Supply =	6,270	
Year-First Inventory =	473	
Current Production =	5,797	
o Consumption =	3,326	
Foodgrains	1,880	1,374
Seeds	35	
Loss	416	
Others	996	
o Sales =	2,729	
To Gov't =	1,355	
To Free Market =	1,374	
o Year-End Inventory =	281	

Non-Farm Households

o Consumption =	3,438
Foodgrains =	3,277
Processing =	161
o Purchasing =	3,438
Gov't channel =	2,129
Free Market =	1,309
o Year-End Inventory =	0.0

2,129

Government

o Supply =	2,601	
Year-First Inventory =		744
Purchase =	1,356	

1,355 Import = 501

o Release = 2,129

o Year-End Inventory =471

Table 11: PRODUCTION AND URBAN-RURAL CONSUMPTION OF RICE BY VARIETY IN RICE YEAR 1979
(Unit = 1,000 M/T)

Production Total 1/	Traditional Variety (T.V.)	High Yielding Variety (H.Y.V.)
5,799	1,263	4,516

Consumption					
Urban Households 2/					
Total:	3,436 2/	T.V.:	996 4/	H.Y.V.:	2,440 4/
Gov't. channel:	1,683 3/	Gov't. channel:	0.0	Gov't. channel:	1,683
Free Market:	1,753	Free Market:	996	Free Market:	757
Rural Households					
Total:	1,631 5/	T.V.:	267 6/	H.Y.V.:	1,364 6/
Gov't. channel:	0.0	Gov't channel:	0.0	Gov't. channel:	0.0
Free Market:	0.0	Free Market:	0.0	Free Market:	0.0

Note:

1/ Production Figures refer to rice harvested in October through November 1978 and are from Agricultural Policy Handbook, MAF 1982 p. 126.

2/ Urban households here refer to non-farm households, and hence are a slight over estimate of real number of urban households. Consumption figures were obtained by per capita yearly consumption multiplied by the number of non-farm people.

3/ In rice year 1979, the government purchased HYV only. We assume that the rice released by the government was bought entirely by urban households.

4/ The differentials between total quantity consumed by urban households and quantity released by the government is assumed to be supplied through free market channels. Further, we assume that the ration of H.Y.V. and T.V. is 71 to 29 percent respectively based on the survey conducted by the National Agricultural Cooperatives Federation (NACF). See "The Report of Rice Marketing Survey (in Korea): NACF, 1978 Septemver p. 356.

5/ Rural households are assumed to consume retained rice from total produce netting out marketed surplus. Total consumption figures are obtained per capita yearly consumption of 149.9 Kg. multiplied by total number of rural people 10,884 thousand persons in rice year 1979.

6/ We assume that all retained T.V. rice was consumed by rural households and the rest fitted by H.Y.V.

Last point in the above table, inventories carried-in and out are ignored. Obviously, the difference between total production of 5,799 and total consumption of 5,067 (= 3,436 + 1,631) would be the inventory carried-over to 1980.

Table 12: Monthly Prices of HYV and Traditional Rice in Free Market in 1978-1982

Price		Year	Month													
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average Price	Release
	Wholesale	1978	23,947	24,031	23,119	22,947	23,004	24,002	25,093	25,149	25,131	25,656	26,948	27,467	24,709	26,500
	Price	1979	26,667	30,358	31,213	31,624	32,675	32,818	33,463	34,219	34,227	34,425	34,398	34,959	32,671	32,000
HYV	(average	1980	35,835	37,550	36,891	36,607	36,669	36,767	37,202	37,381	39,631	45,670	45,653	48,756	34,551	44,000
	over 16	1981	48,937	48,885	49,032	49,422	50,833	55,593	57,447	58,357	56,644	52,993	50,848	50,296	52.444	44,000
	cities)	1982	49,958	50,354	50,400	50,400	50,400									
															Purchase Price	
	Farm Gate	1978	23,329	23,336	22,425	22,428	22,556	23,542	24,729	24,499	24,420	24,848	25,737	26,945	24,016	30,000
	Price	1979	27,061	29,428	30,384	30,802	32,664	32,367	32,775	33,280	33,438	33,500	33,337	33,910	31,912	36,600
Rice	(average over	1980	34,713	36,484	35,725	35,425	35,540	35,732	36,057	36,310	38,315	43,864	43,736	46,809	38,227	45,750
	producing	1981	47,098	46,859	46,833	41,169	48,752	53,462	54,949	56,090	54,035	51,171	49,223	48,973	50,384	52,160
	regions)	1982	48,612	40,140	49,208	49,042	49,042									
	Wholesale	1978	25,047	25,729	25,343	25,799	26,674	26,819	-	-	27,845	28,810	29,878	30,292	27,224	
	Price	1979	30,904	33,099	34,276	34,253	35,030	35,737	37,572	40,137	40,705	40,593	39,402	38,707	36,701	
Traditional	(average	1980	39,593	42,311	41,840	41,461	42,524	42,965	43,695	44,472	50,907	54,734	53,036	57,147	46,224	
	over 16	1981	57,088	55,971	55,293	55,339	56,467	61,721	63,443	64,660	63,165	58,828	54,687	53,071	58,311	
	cities)	1982	52,270	54,508	54,438	57,703	64,254	65,806								
	Farm Gate	1978	25,041	25,376	25,217	25,505	25,978	26,017	-	-	27,341	28,241	28,966	29,782	26,746	
	Price	1979	30,016	32,267	33,347	33,377	33,949	34,823	36,300	28,294	38,803	39,083	38,122	37,553	35,495	
Rice	(average over	1980	38,311	41,040	40,446	40,299	40,962	44,746	42,603	43,383	49,276	53,018	51,678	55,398	44,847	
	3 producing	1981	55,442	54,294	53,529	63,625	54,559	60,042	61,818	63,471	61,660	57,409	53,247	51,456	56,713	
	regions)	1982	50,720	53,224	53,229	55,924	62,718	64,445								

Source: Statistical Survey Section, MAF, 1982.

Table 13: FREE MARKET PRICES OF RICE BY VARIETY
(Unit = Won/80 Kg. of Medium Grade)

Year	HYV.				Traditional Variety	
	Urban 1/ Wholesale Price	Gov't. Releasing Price	Farm 2/ Gate Price	Gov't Purchasing Price	Urban 1/ Wholesale Price	Farm 2/ Gate Price
1978	24,709	26,500	24,066	30,000	27,224	26,746
1979	32,671	32,000	31,912	36,600	36,701	35,495
1980	39,551	44,000	38,227	45,750	46,224	44,847
1981	52,441	44,000	50,384	52,160	58,311	56,713

Note: 1/ Average price from, 16 cities.

2/ Average price from 12 producing areas.

Source: Supplied by the Survey Section, MAF.

off-harvest season, from June through October. The government releases the bulk of its rice in the off harvest season. This uniform release price does not allow the recovery of incurred storage costs, and has discouraged private investment in storage facilities.7/

Average purchase and release prices are presented in Table 13. Note By comparing Tables 12 and 13, that although the government release price for HYV rice is higher than the average wholesale price, it is lower than the peak price. Note also that it is substantially lower than the average traditional price. The government purchase price for HYV is higher than the peak purchase price, and in some years higher than the traditional price as well.

As the government purchase price is higher than the free market price, and as in some years the government has not bought all of the high yield crop, a word about the allocation mechanism of government purchase quantities is in order. Sometime near the harvest season, the government determines its procurement quota, based on estimated supply and demand, existing inventories, the general price level, and the expected price of rice. Each farmer then receives a government procurment quota, in proportion to his total quantity of HYV rice, with some priority given to small farmers.

Table 14 gives supply and demand for aggregate rice, by source. Note that Korea relies heavily on imports to make up for any shortfall in production: in 1981, 33 percent of the total rice stock was imported. Imported rice is usually Japonica rice from the United States and is really a traditional variety. However, since it is released in delay, its quality

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7/ Cf. George S. Tolley, et al., Agricultural Price Policies and the Developing Countries, a World Bank Publication, Hohns Hopkins University Press, 1982.

Table 14: Overall Supply and Demand for Rice in Korea by Rice Year

(Unit : polished 1,000 M/T)

Rice Year	1978	1979	1980	1981
Classification				
Supply				
Inventory Carried-In	1,076	1,218	752	1,066
(Government)	(953)	(744)	(471)	(476)
(Private)	(123)	(534)	(281)	(590)
Production	6,006	5,797	5,136	3,550
Import	-	501	580	2,245
Total	7,082	7,516	6,468	6,861
Demand				
Foodgrains	4,986	5,099	5,057	5,091
(Farm Households)	(1,846)	(1,880)	(1,590)	(1,527)
(Non-Farm Households)	(3,140)	(3,219)	(3,467)	(3,564)
Processing	221	218	36	36
Export	80	0.0	0.0	0.0
Seeds	35	35	45	45
Loss	420	416	261	194
Others	122	996	3	0.0
Sub-total	5,864	6,764	5,402	5,366
Inventory Carried-Out	1,218	752	1,066	1,495
Total	7,082	7,516	6,468	6,861
Per Capita Consumption (polished kg)	134.7	135.6	132.4	131.5

Source: Grain Management Bureau, Ministry of Agriculture and Forestry, 1982.

Table 15: Supply and Demand for Barley Polished in Rice Year 1979

(Unit : 1,000 M/T)

o Inventory		o Consumption	530
Carried-In	1,104	Farm Households	361
Government	634	Non-Farm Households	169
Private	470	o Processing	93
		o Seeds	55
o Current		o Feedgrains	76
Production	1,508	o Loss and Others	532
Gov't Purchase	560		
Private Holding	948	Sub-Total	1,286
o Total	2,612	o Carried-Out	1,326
o Gov't Release to Market	185	Government	738
		Private	588
		o Total	2,612

Source: Grain Management Bureau, MAF, 1982.

deteriorates and it is treated for the modelling purpose as indistinguishable from HYV.

III.3 Marketing Barley

Despite the declining importance of barley as a foodgrain, it remains a substantial contributor to the GMF deficit, in 1980 contributing nearly as much as rice to the total deficit.

Table 15 presents supply and demand by source for barley. Some salient features stand out: stocks of barley, both private and government, are substantial, reaching 88 percent of current production in 1979. Also, assuming that barley sold by the government was purchased by urban consumers, there was virtually no private market for barley in 1979. This second point is supported by the fact that the government release price of barley has been constant from 1978 to 1980, yet in 1978 it was already at about half of the procurement price.8/ Additional marketing tables for 1979 and 1980 are presented in the Annex. Procurement procedures for barley are the same as those for rice.

III.4 Modelling the GMF Deficit

For modelling purposes, we obtained the costs per bag incurred by the GMF for rice and barley, which are presented in Table 16. The next to last row presents total GMF deficits as calculated from per-bag figures; the last row presents the official MAF budget figures.

The substantial discrepancies between the official and the calculated deficit may be explained as follows: i) Per bag figures are calculated on the

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8/ Note that the change in inventory in Table 13 is not consistent: inventory carried in + purchases - sales amounts to 1,009 thousand metric tons (tmt), whereas inventory carried out is given as 738 tmt, leaving a discrepancy of 271 tmt.

Table 16: Government Cost Per Unit of Grains and Deficit in the Grain Management Operation in 1978-1980

(Unit : Won unless otherwise specified)

	Rice (per bag of 80 kg)			Barley (per bag of 76.5 kg)		
Rice Year	1978	1979	1980	1978	1979	1980
Cost						
(1) Purchase Price	26,200	30,000	36,834	18,500	22,000	26,400
(2) Release 1/ Price	20,900	25,847	30,854	10,120	10,120	10,120
(3) Difference (3)=1-2	5,300	4,153	5,980	8,380	11,880	16,280
(4) Storage & Handling Cost	3,040	3,854	5,701	1,376	1,779	2,753
(5) Deficit Per Bag (5)=3+4	8,340	8,007	11,681	9,756	13,659	19,033
(6) Deficit Per 2/ Seok	15,012	14,412	21,026	17,560	24,586	34,259
(7) Quantity Released in 1,000 Seok	8,215 (1,183)	11,686 (1,683)	12,099 (1,742)	1,939 (268)	1,343 (185)	2,867 (396) 3/
(8) Total Deficit in Billion Won (8)=(6)x(7)	1,233	1,684	2,544	341	331	982
(9) Total Deficit 4/ according to MAF Fiscal Budget Account	1,540	1,851	1,400	145	285	1,068

Note: 1/ Average prices during a given rice year.

2/ Rice: One Seok = 144 kg = 1.8 bags
Barley: One Seok = 138 kg =1.8 bags

3/ Fiscal year runs on the calendar year basis.

4/ Figures in the parentheses are in 1,000 metric tons.

Source: Grain Management Bureau, MAF, 1982

basis of commodity flows over the rice year; whereas budget deficits follow the fiscal year, which begins two months earlier. ii) Price differentials and average storage costs are difficult to determine, as only a fraction of the quantity purchased in any given year is released to the market. iii) In fiscal accounting, additions to inventory are counted as costs, and sales from inventory are counted as revenue. Thus when stocks are accumulating, the deficit will be overstated. iv) The repayment of expired grain bonds and loans is treated as an expense in the budget. Despite these discrepancies, we model the deficit on a per bag basis (alternative i), as the most realistic measure of incurred costs9/.

IV. The Fertilizer Market

IV.1. Historical Overview

The fertilizer sector in Korea has grown very rapidly. In 1965, domestic production was able to meet only 19 percent of domestic agricultural demand for fertilizer; by 1981, total fertilizer production had increased by about 16 times, to a level which was one and one-half times domestic demand (Annex Table 12). In the same period, average per acre application of fertilizer land tripled from 110 to 300 kg per hectare, a sudden rise occurring in the mid-1970's when HYV rice was introduced on a large scale (Table 17). Intensity of fertilizer use in Korea is now among the highest in the world.

9/ See also Tolley, et al., op cit.

Table 17: Fertilizer Application

(Unit: Kg/one Ha of Cultivated Land by Crop)

Year	Total Cultivated Land 1/	Rice	Common Barley	Naked Barley	Wheat
1965	110	345	267	330	234
1966	122	348	307	387	318
1967	136	352	301	358	315
1968	134	369	330	432	323
1969	148	363	313	404	304
1970	162	331	299	422	322
1971	183	314	297	391	322
1972	198	370	463	394	323
1973	247	345	350	414	-
1974	270	395	350	389	418
1975	282	460	377	508	437
1976	203	499	412	506	449
1977	243	524	410	547	383
1978	289	513	432	566	442
1979	297	486	410	521	388
1980	285	486	406	513	403
1981	300	459	396	513	401

Note: 1/ Includes double cropped area.

Source: - Agricultural Policy Handbook, MAF, 1982, p. 204
- Report on the Results of Production Cost Survey of Agricultural Products, MAF, Various Issues.

Table 18: Overall Demand and Supply of Fertilizer

(Unit : 1,000 Nutrient M/T)

Year / Item	1978	1979	1980	1981 1/
Total Demand	2,089	2,183	1,731	1,953
Agricultural Use	866(95)	863(94)	827(95)	850(95)2/
Industrial Use	50(5)	52(6)	41(5)	42(5)
Export	504	559	341	626
Carried-Out	669	709	522	435
Total Supply	2,089	2,183	1,731	1,953
Carried-In	689	669	709	522
Import	62	58	48	none
Production	1,338	1,456	974	1,431

Note: 1/ Planned figures

2/ Number in the parentheses are relative percentage between agricultural and industrial wage.

Source: Farm Production Bureau, MAF, 1982.

Table 18 presents total demand and supply of fertilizer in recent years. Domestic production and inventory carry-over far outstrip domestic demand. Decomposing fertilizer supply and demand by element (Annex Table 13), it is seen that nitrogen and phosphate are more than adequate to meet demand, but that potash must still be imported on a small scale.

The currrent high intensity of fertilizer use, and the decline in barley and HYV rice production, indicate that fertilizer demand cannot be expected to significantly increase. The demand for fertilizer has shifted from urea and phosphate to compound fertilizer, increasing from 38 to 66 percent of total consumption from 1970 to 1981.

IV.2. Joint Venture Decrees and Cost Structures

In the early 1960's, the Korean government began an ambitious plan to develop the fertilizer industry not only for domestic consumpiton, but also for export. In consequence, nine companies have been established since the early 60's. Of these, three[10/] were either established, or augmented as joint ventures with American fertilizer firms. Most of the compound fertilizer is produced by these three firms; in 1979 the three companies produced 76 percent of total domestic consumption.

Under the joint venture decrees, the firms are guaranteed by the Korean government a return of at least 20 percent. The government is obligated to purchase a set quantity of fertilizer, at a price such that the contracted level of profit is obtained. Hence, in our model, the price of fertilizer is taken to be fixed.

This rigid price structure, and the comparative disadvantage of Korea in

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10/ Yong-nam, Chinhae, and Namhae Chemical Co., Ltd.

the production of ammonia from naptha[11/], have caused domestically produced fertilizer to be non-competitive in international markets. Export prices of

Table 19: Export Prices and Production Cost of Urea and Compound Fertilizer (DAP) in 1979

(Unit = Won /M/T)

Fertilizer	Urea			DAP		
Company	A	B	C	D	B	C
Price						
Export Price (FOB)	92,150	92,150	92,150	106,700	106,700	106,700
Total Prodn Cost	113,903	159,297	143,684	147,970	170,957	149,340
Variable Cost	70,443	76,739	78,696	91,308	97,413	92,282
Fixed Cost	21,707	15,411	13,459	15,392	9,287	14,418
Government Purchasing Price from Industry	100,233	N.A.	140,851	140,073	145,830	137,478
Government Releasing Price to Farmers						
(Before Dec. 18, 1979)	122,240	122,240	122,240	98,004	98,004	98,004
(After Dec. 18, 1979)	746,720	146,720	146,720	117,680	117,680	117,680

Source: Economic Planning Board, 1980.

11/ See Joseph Wambia "Policy Issues in Korean Agriculture" (Mimeo), World Bank, p. 62.

the three major companies were below production costs in 1979 (see Table 19). Korean export prices, which must be set competitvely with world prices, have been below the government sales and purchase prices as well. The Government must compensate the joint venture firms at a loss. The Government price supports for fertilizer producers will continue at least up to the mid-1980's, when the joint venture decrees expire.

V. Operations of the Fertilizer Fund (FF)

V.1. Marketing of Fertilizers

In Korea, the marketing of fertilizers for agricultural use is handled exclusively by the National Federation of Agricultural Cooperatives (NACF), which purchases from manufacturers and sells to farmers through its nation-wide network.

At the end of each year, the government informs each fertilizer company of its procurement plan, including price and quantity, and enters into a purchase contract. At the same time the government announces the selling price of fertilizer to farmers. Fertilizer is then acquired by the NACF, and distributed at the government release price through its designated dealers.

As discussed above, the government purchases fertilizer from the companies at a higher price than that at which it sells to farmers, and exports at a still lower price. Thus, the fertilizer deficit arises from price differences between purchases and sales, from handling and storage costs, and from export compensation.

2. Deficit of the FF Operation 12/

Table 20 shows a detailed breakdown of the FF deficit during the period from 1977 to 1982. By the end of 1981 the total cumulative deficit reached

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12/ Like the GMF, the Fertilizer Fund operates as a special account of the government budget.

Table 20: Breakdown of FF Deficit

(Unit = Current One Billion Won)

Year	1977	1978	1979	1980	1981	1982
Item						
o Deficit due to Price Difference	13.7	1.4	-21.2	-39.2	-68.9	-43.4
Sales Revenue by Government	144.6	170.3	166.9	195.4	290.6	344.1
Purchasing Value from Industry	130.9	168.9	188.1	234.6	359.5	387.5
o Handling & Other Expenses	-19.1	-26.2	-34.3	-90.9	-99.8	-104.2
Transport and Handling Cost	13.3	19.1	22.2	26.0	32.1	37.1
Interest on Borrowing	5.8	4.8	7.8	35.4	53.6	67.1
Export Compensation & Other	None	2.3	4.2	29.5	14.1	None
o Sub-Total Deficit (A)	-5.4	-24.8	-55.4	-130.1	-168.7	-147.6
o Other Revenue (B)2/	2.9	5.1	7.1	4.4	6.4	10.1
o Total Deficit in Current Year C=(A-B)	-2.5	-19.7	-48.3	-125.7	-162.3	-137.5
o Cumulative Total Deficit	-103.5	-123.2	-171.5	-297.2	-459.5	-597.0
o Central Government Expenditure (D)	3,251	4,505	5,975	8,110	10,6953/	N.A.
o (C/D)x100	0.078	0.44	0.81	1.55	1.52	N.A.
o GNP (E)	17,021	22,918	29,072	34,322	42,397	N.A.
o (C/E) x 100	0.015	0.086	0.166	0.366	0.383	N.A.

Note: 1/ Planned figures

2/ Other revenue includes basically interest receipt on FF operation

3/ Preliminary figures

Source: Agricultural Policy Handbook, MAF, p. 135, 1982.

460 billion won, compared with a cumulative GMF deficit of 1,120 billion won. As with the GMF deficit, the FF deficit is financed primarily by long-term borrowing from the central bank, and is of major concern in the management of the national money supply. In 1981 alone the FF deficit was 162.3 billion won, or 1.5 percent of central government expenditure. Note in Table 18 that the deficit due to handling, storage, and other expenses is greater than the deficit due to price differences. For example, in 1979, total other expenses were 1.6 times the deficit attributable to price differences.

In Table 21 we present a detailed version of the FF operation in 1979. Government purchase prices by element of fertilizer are derived either as a weighted average of prices across companies, or as the purchase price agreed to by the company which has the largest purchase contract. To calculate the fertilizer deficit in the model for rice year 1979 13/, we use aggregate quantity over types of fertilizer sold, and weighted averages of purchase and sales price.

13/ Strictly speaking, the fertilizer deficit equation should be specified with the portion of the fertilizer deficit applicable to rice cultivated during 1978 plus the deficit attributable to fertilizers applied to barley cultivated during November 1978 and May 1979. However, no data is available with this breakdown.

Table 21: Fertilizer Fund Deficit by Element in 1979

Fertilizer Element	Revenues: Quantity Sold to Farmers (Gross M/T)	Revenues: Total Sales Value (Million Won)	Revenues: Sales Price Per Unit (Won/M/T)	Expenditures: Quantity Purchased from Industry (Gross M/T)	Expenditures: Total Purchased Value (Million Won)	Expenditures: Purchasing Price per Unit (Won/M/T)
Urea	548,080	66,997	122,240	670,841	94,493	140,857
Phosphate	175,471	15,079	85,934	172,700	14,558	84,296
Potash	83,187	3,499	42,062	59,000 1/	4,500 1/	77,586 1/
21-17-17	188,583	18,602	98,640	160,000	21,383	133,642
22-22-11	386,062	39,703	102,840	136,805	19,267	140,833
17-21-17	None	None	None	304,706	39,989	131,238
18-18-18	80,809	7,535	93,245	80,000	10,249	128,112
Others	343,078	25,468	74,234	15,160	13,061	861,544
Total	1,805,270	176,883	97,981 2/	1,583,052	217,500	137,393 3/

Total Deficit = 176,883 - 255,300 = -40,617 (million Won)

Additional Cost Item	Total Additional Cost (Million Won)	Total Additional Cost per Unit (Won/M/T)
Handling & Storage	20,900	13,202
Interest	8,300	5,396
Export Compensation	4,100	2,590
Grand Total	255,300	161,271

Note: 1/ All potash is imported.

2/ Weighted average selling price to farmers.

3/ Weighted average purchasing price form industries ignoring additional cost items.

4/ Weighted average purchasing price from industries plus additional cost per unit.

Source: Farm Production Bureau, MAF, 1982

VI. Statistical Annex

List of Tables

Table 1: Farm Population and Area Cultivated Per Household

Year	Total Population (a) (persons)	Farm Population (b) (persons)	(B/A)x100	Number of Farm Households	Land Area Per Household		Utilization Rate (%)
					Total (in Ha)	Paddy (in Ha)	
1960	14,559,271		2,349,506	0.862	0.514	138.4	
1965	28,705,000	15,811,575	51.7	2,506,899	0.900	0.513	147.1
1970	31,345,000	14,421,730	45.9	2,483,318	0.925	0.513	142.1
1971	32,883,000	14,711,828	44.7	2,481,525	0.915	0.510	136.5
1972	33,505,000	14,676,944	43.8	2,451,844	0.914	0.514	137.2
1973	34,103,000	14,644,566	42.9	2,450,277	0.915	0.515	136.0
1974	34,692,000	13,459,195	38.8	2,381,200	0.940	0.533	138.2
1975	35,281,000	13,244,021	38.2	2,379,058	0.941	0.536	140.4
1976	35,860,000	12,785,456	35.7	2,335,856	0.958	0.552	141.7
1977	36,436,000	12,308,834	33.8	2,303,930	0.968	0.565	135.5
1978	37,019,000	11,527,459	31.1	2,223,807	0.999	0.590	134.5
1979	37,605,000	10,883,422	28.9	2,161,821	1.021	0.606	130.9
1980	38,124,000	10,830,585	27.1	2,155,915	1.018	60.6	125.3

Note: a) Upland area equals to total area minus paddy.
b) Utilization rate is derived by total area cultivated including doubling cropping divided by total physical size of land and multiplied by 100.

Source: Yearbook of Agriculture and Forestry Statistics, MAF, 1981.

Table 2: Yearly Consumption per Capita by Crop and Farm and Non-Farm Households

Year	Rice Polished			Barley Polished			Wheat Flour		
	F-H	NF-H	Average	F-H	NF H	Average	F-H	NF-H	Average
1965	116.0	126.9	120.9	67.1	30.0	50.0	N.A.	N.A.	N.A.
1970	123.0	147.6	136.4	58.1	19.9	37.3	9.6	2.9	13.8
1972	125.3	141.7	134.5	59.6	18.6	37.5	8.9	5.0	24.9
1975	129.4	120.1	123.6	51.7	27.0	36.3	3.1	4.7	29.5
1976	127.4	115.7	120.1	52.5	24.6	34.7	3.6	4.8	30.2
1977	135.3	121.7	126.4	44.4	20.0	28.5	3.4	6.6	30.3
1978	145.8	129.2	134.7	32.8	10.8	18.1	3.8	6.4	30.5
1979	149.9	129.4	135.8	28.8	7.7	14.1	3.9	5.5	30.6
1980	150.7	125.5	132.4	29.1	7.9	13.8	3.7	4.9	29.4
1981	147.3	125.8		30.9	10.8		5.1	5.2	

Note: F-H = Farm Households
NF-H = Non-Farm Households

Source: Report on the Results of Food Grain Consumption Survey, MAF. Rice Year 1981.

Table 3: Supply and Demand for Government Rice in Recent Rice Years

(Unit = polished, 1000 M/T)

Rice Year	1978	1979	1980	1981
Item				
Supply				
Inventory carried in	953	745	471	476
Purchase	1,403	1,355	1,301	549
Imports	0.0	0.0	580	2,245
Others	0.0	0.0	31	16
Total	2,356	2,601	2,383	3,286
Demand				
Market Release	1,184	1,683	1,742	1,560
Government Consumption	133	189	152	150
Processing	210	211	0.0	0.0
Loan and Others	3	47	13	81
Exports	81	0.0	0.0	0.0
Sub-total	1,601	2,130	1,907	1,791
Inventory carried out	745	471	476	1,495
Total	2,356	2,601	2,383	3,286

Source: Grain Management Bureau, MAF, 1982.

Table 4: Government Procurement by Rice Variety

Rice Year	Total polished Rice Procured (in 1000 M/T)	Rice Variety (in percent)					
		Traditional Rice	H.Y.V. Rice				
			Milyang	Nopung	Yushin	Tongil	Other
1977	1,403	2.0	24.0	0.0	44.0	27.0	3.0
1978	1,301	1.6	70.0	0.9	23.9	2.8	0.8
1980	546	0.4	24.1	2.8	71.6	0.4	0.7
1981	915	11.0	35.3	0.0	51.0	0.0	2.7

Source: Grain Management Bureau, MAF, 1982.

Table 5: Government Procurement of Rice by Grade

Rice Year	Total Polished Rice Procured (in 1000 M/T)	1st Grade	2nd Grade	3rd Grade	Off Grade
			(in percent)		
1977	1,403	35.3	52.7	11.3	0.7
1978	1,355	14.1	41.3	29.4	15.2
1979	1,301	50.9	41.9	0.0	7.2
1980	546	45.0	47.8	0.0	7.2
1981	915	60.8	37.1	0.0	2.1

Source: Grain Management Bureau, MAF, 1982.

Table 6: Supply and Demand for Barley Polished in Rice Year 1978

(Unit : 1,000 M/T)

Supply		Demand	
o Inventory Carried-in	881	o Consumption	679
		Farm Households	416
		Non-Farm Households	263
Government	487		
Private	394		
		o Processing	63
		o Seeds	60
o Current Production	1,348	o Feedgrains	71
		o Loss and Others	252
Gov't Purchasing	484	Sub-total	1,125
Private	864		
o Total	2,229	o Carried-Out	1,104
		Government	634
		Private	470
		o Total	2,229

Source: Grain Management Bureau, MAF, 1982.

Table 7: Supply and Demand for Barley Polished in Rice Year 1980

Supply		Demand	
o Inventory		o Consumption	527
Carried-In	1,326	Farm Households	307
Government	738	Non-Farm Households	220
Private	588		
o Current		o Processing	221
Production	811	o Seeds	30
Gov't Purchase	361	o Feedgrains	104
Private	450	o Loss and Others	525
		o Sub-total	1,407
o Total	2,137		
		o Carried-Out	730
		Government	412
		Private	654
		o Total	2,137

Source: Grain Management Bureau, MAF, 1982

Table 8: Flow of Rice Among Sectors in Rice Year 1978

(Unit = Polished 1,000 M/T)

Farm Households

- Supply : 6,057
  - Year-First Inventory 51
  - Current Production : 6,006
- Consumption : 2,335
  - Foodgrains : 1,846
  - Seeds : 35
  - Loss & others 454
- Sales : 3,248
  - To Gov't 1,403
  - To Free Market 1,845
- Year-End Inventory 473

1,845

1,403

Non-Farm Households

- Consumption 3,361
- Purchase : 3,376
  - Gov't channel : 1,845
  - Free Market : 1,531
- Year-End Inventory 0.0
- Statistical Discrepancy 15

1,531

Government

- Supply 2,356
  - Year-First Inventory 953
  - Purchase 1,403
- Release 1,531
- Export 80
- Year-End Inventory 744

Source: Grain Management Bureau, MAF, 1982

Table 9: Flow of Rice Among Sectors in Rice Year 1980

(Unit = Polished 1,000 M/T)

Farm Households

- o Supply : 5,416
  - Year-First Inventory : 281
  - Current Production : 5,136
- o Consumption : 1,899
  - Foodgrain : 1,590
  - Seeds : 45
  - Loss : 265
- o Sales : 2,927
  - To Gov't 1,301
  - To Free Market : 1,626
- o Year-End Inventory : 590

1,626

Non-Farm Households

- o Consumption : 3,503
- o Purchase : 3,533
  - Gov't Channel : 1,907
  - Free Market : 1,626
- o Year-End Inventory : 0.0
- o Statistical Discrepancy : 30

1,907

Government

- o Supply : 2,383
  - Year-First Inventory : 471
  - Purchase : 1,301
  - Import : 580
  - Others : 31
- o Release : 1,907
- o Year-End Inventory : 476

1,301

Source: Grain Management Bureau, MAF, 1982.

Table 10: Flow of Rice Among Sectors in Rice Year 1981

(Unit : polished 1000 M/T)

Farm Households

- o Supply : 4,222
  - Year-First Inventory : 590
  - Current Production : 3,550
  - Loan from Gov't : 82
- o Consumption : 1,766 1,944
  - Foodgrains : 1,527
  - Seeds : 45
  - Loss : 194
- o Sales : 2,493
  - To Gov't : 549
  - To Free Market : 1,944

1,709

- o Year-End Inventory : -37

Non-Farm Households

- o Consumption : 3,600
- o Purchase : 3,653
  - Gov't Purchase : 1,709
  - Free Market : 1,944
- o Year- End Inventory : 0.0
- o Statistical Descrepancy : 53

*82 **Government**

- o Supply : 3,287
  - Year-First Inventory : 476
  - Purchase : 549

549

  - Import : 2,245
  - Other : 16
- o Release : 1,791
- o Year-End Inventory : 1,495

* Loan to farm households below poverty level

Source: Grain Management Bureau, MAF, 1982.

Table 11: Monthly Prices of HYV and Traditional Rice in Free Market in 1978-1982

Price		Year	Month													
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average	Release Price
	Wholesale	1978	23,947	24,031	23,119	22,947	23,004	24,002	25,093	25,149	25,131	25,656	26,948	27,467	24,709	26,500
	Price	1979	26,667	30,358	31,213	31,624	32,675	32,818	33,463	34,219	34,227	34,425	34,398	34,959	32,671	32,000
HYV	(average	1980	35,835	37,550	36,891	36,607	36,669	36,767	37,202	37,381	39,631	45,670	45,653	48,756	34,551	44,000
	over 16	1981	48,937	48,885	49,032	49,422	50,833	55,593	57,447	58,357	56,644	52,993	50,848	50,296	52.444	44,000
	cities)	1982	49,958	50,354	50,400	50,400	50,400									
																Purchase Price
	Farm Gate	1978	23,329	23,336	22,425	22,428	22,556	23,542	24,729	24,499	24,420	24,848	25,737	26,945	24,016	30,000
	Price	1979	27,061	29,428	30,384	30,802	32,664	32,367	32,775	33,280	33,438	33,500	33,337	33,910	31,912	36,600
Rice	(average over	1980	34,713	36,484	35,725	35,425	35,540	35,732	36,057	36,310	38,315	43,864	43,736	46,809	38,227	45,750
	producing	1981	47,098	46,859	46,833	41,169	48,752	53,462	54,949	56,090	54,035	51,171	49,223	48,973	50,384	52,160
	regions)	1982	48,612	40,140	49,208	49,042	49,042									
	Wholesale	1978	25,047	25,729	25,343	25,799	26,674	26,819	-	-	27,845	28,810	29,878	30,292	27,224	
	Price	1979	30,904	33,099	34,276	34,253	35,030	35,737	37,572	40,137	40,705	40,593	39,402	38,707	36,701	
Traditional	(average	1980	39,593	42,311	41,840	41,461	42,524	42,965	43,695	44,472	50,907	54,734	53,036	57,147	46,224	
	over 16	1981	57,088	55,971	55,293	55,339	56,467	61,721	63,443	64,660	63,165	58,828	54,687	53,071	58,311	
	cities)	1982	52,270	54,508	54,438	57,703	64,254	65,806								
	Farm Gate	1978	25,041	25,376	25,217	25,505	25,978	26,017	-	-	27,341	28,241	28,966	29,782	26,746	
	Price	1979	30,016	32,267	33,347	33,377	33,949	34,823	36,300	28,294	38,803	39,083	38,122	37,553	35,495	
Rice	(average over	1980	38,311	41,040	40,446	40,299	40,962	44,746	42,603	43,383	49,276	53,018	51,678	55,398	44,847	
	3 producing	1981	55,442	54,294	53,529	63,625	54,559	60,042	61,818	63,471	61,660	57,409	53,247	51,456	56,713	
	regions)	1982	50,720	53,224	53,229	55,924	62,718	64,445								

Source: Statistical Survey Section, MAF, 1982.

Table 12: Production and Consumption of Fertilizer

Item Year	Total Production 1/ (1,000 Nutrient M/T)	Total Consumption 2/ (1,000 Nutrient M/T)	Kg/Ha	Self-Sufficiency Ratio (%)
1965	75	393	110	19
1967	186	479	136	39
1970	590	563	162	105
1971	599	605	183	99
1972	635	648	198	98
1973	672	793	247	85
1974	750	837	270	90
1975	860	886	282	97
1976	833	643	203	129
1977	1,089	736	243	148
1978	1,330	866	289	154
1979	1,438	863	297	167
1980	1,345	828	285	162
1981	1,168	830	300	141

Note: 1/ Including the production for industrial use
2/ Only for Agricultural use

Source: Agricultural Policy Handbook, MAF, 1982, p. 130

Table 13: Production and Consumption of Fertilizer by Element
(Unit = 1,000 Nutrient M/T)

Item / Year	Nitrogen			Phosphate			Potash		
	Prodn.	Cons.	Self-Suf. Ratio (%)	Prodn.	Cons.	Self-Suf. Ratio (%)	Prodn.	Cons.	Self-Suf. Ratio (%)
1965	75	218(55)	34	None	123(31)	0.0	None	52(14)	0.0
1967	156	271(57)	58	21	133(28)	16	9	76(15)	12
1970	400	356(63)	112	140	124(22)	112	50	83(15)	60
1971	408	347(57)	118	144	165(27)	87	47	93(15)	50
1972	418	373(58)	112	163	171(26)	95	54	104(16)	52
1973	448	411(52)	109	159	232(29)	69	65	150(19)	44
1974	514	449(54)	114	166	232(28)	72	70	156(18)	45
1975	583	481(54)	121	196	238(27)	82	82	167(19)	49
1976	534	361(56)	148	215	142(22)	151	84	140(22)	60
1977	669	388(53)	172	309	210(28)	147	111	138(19)	64
1978	788	461(53)	171	421	231(27)	182	121	174(20)	70
1979	838	444(52)	189	488	227(26)	215	112	192(22)	58
1980	727	448(54)	162	493	196(24)	251	125	184(22)	68
1981	666	432(52)	154	324	199(24)	163	178	199(24)	89

Note: 1/ Production figures include agricultural plus industrial uses but consumption firgures include agricultural use only.

2/ The consumption figures are same as the amount of fertilizers sold to farmers by the government.

3/ The numbers in the parentheses indicate relative percentage by element.

Source: Agricultural Policy Handbook, MAF, 1982, p.134.

Table 14: Overall Demand and Supply of Fertilizer by Element
(Unit = 1,000 Gross M/T)

Year	1977	1978	1979	1980	1981 1/
Item					
Total Supply	3,569	4,025	3,977	3,787	3,555
Production in Current Year	2,437	2,895	3,091	2,854	2,849
Urea	906	1,067	1,186	958	1,143
DAP	1,052	1,310	1,362	1,352	1,239
Others	479	518	543	544	467
Carried-In	1,132	1,130	886	933	706
Total Demand	2,439	3,139	3,044	3,081	2,362
Domestic in Demand	1,766	2,012	1,929	1,771	1,633
Urea	622	726	672	667	560
DAP	606	772	866	887	873
Others	538	514	391	217	200
Export	673	1,127	1,115	1,310	729
Urea	334	454	244	400	233
DAP	176	421	610	670	296
Others	163	252	211	232	200
Carried-Out	1,130	886	933	706	1,193

Note: 1 Preliminary figures

Source: Farm Production Bureau, MAF, 1982

Table 15: Sales of Single Element Fertilizer and Complex Fertilizers

(Unit = 1,000 Nutrient M/T)

Year	Single Element	Complex	Total Consumption
1970	342(62)	216(38)	563
1974	517(62)	320(38)	837
1975	590(67	296(33)	886
1976	349(54)	294(46)	643
1977	347(49)	289(51)	736
1978	396(46)	470(54)	866
1979	344(40)	519(60)	863
1980	308(37)	520(63)	828
1981	280(34)	650(66)	830

Note: The numbers in the parentheses indicate relative percentage.

Source: Agricultural Policy Handbook, MAF, 1982.

Table 16: Demand and Supply of Fertilizer for Agricultural Use

(Unit = 1,000 Nutrient M/T)

Year	1978	1979	1980	1981 1/
Item				
Demand	1,488	1,430	1,229	1,194
Sales	866	863	827	850
Carried-Out	622	567	402	344
Supply	1,488	1,430	1,229	1,194
Carried-In	582	622	567	402
Import	62	58	48	None
Purchase	844	750	614	792

Note: 1/ Planned figures

Source: Farm Production Bureau, MAF, 1982.

Table 17: Fertilizer Deficit by Element in 1980

Fertilizer Element	Quantity Sold to Farmers (Gross M/T)	Total Sales Value (Million Won)	Sales Price Per Unit (Won M/T)	Quantity Purchased from Industry (Gross M/T)	Total Purchased Value (Million Won)	Purchasing Price Per Unit (Won /M/T)
Urea	568,420	83,399	146,721	502,883	101,762	202,357
Phosphate	175,122	4,144	55,164	173,000	20,758	119,990
Potash	45,905	2,319	50,517	48,000 1/	5,700	118,750
21-17-17	400,833	47,457	118,396	330,942	66,662	201,430
22-22-11	139,146	17,176	123,439	None	None	None
17-21-17	None	None	None	185,600	36,034	194,150
18-18-18	80,809	10,228	126,570	80,000	16,076	200,955
Others	343,078	41,502	120,970	10,000	32,008	3,200,800
Total	1,805,270	206,225	114,235 2/	1,320,425	279,000	211,296 3/

Total Deficit = 206,225 - 370,700 = -164,475 (Million Won)

Additional Cost Items	Total Additional Cost (Million Won)	Additional Cost per Unit (Won /M/T)
Handling & Storage	26,000	19,691
Interest	36,200	27,415
Export Compensation	29,500	22,231
Grand Total	370,700	280,743 4/

Note: 1/ All potash is imported.
2/ Weighted average selling price to farmers.
3/ Weighted average purchasing price from industries ignoring additional cost items.
4/ Weighted average purchasing price from industries plus additional cost per unit.

Source: Farm Production Bureau, MAF, 1982.

Appendix B

The Formal Model

Rural Sector

Production (per household; households indexed by r = 1 to 4 indicating size of landholding).

Profit functions:

$$\log \pi_n^r = \alpha_o^n + \sum_{i=1}^{3} \alpha_i^n \log \frac{W_i}{P_n^R} + \frac{1}{2} \sum_{j=1}^{3} \sum_{i=1}^{3} \gamma_{ij}^n \log \frac{W_i}{P_n^R} \log \frac{W_j}{P_n^R} + \sum_{i=1}^{3} \beta_{ik}^n \log K_n^r \log \frac{W_i}{P_n^R} + \beta_k^n \log K_n^r + \frac{1}{2} \beta_{kk}^n (\log K_n^r)^2$$

n = H high yield variety rice

T traditional variety rice

B barley

i = L labor

F chemical fertilizer

O other inputs

Supply functions:

$$Q_n^r = \frac{\partial \pi_n^r}{\partial P_n^R} = \pi_n^r \left(1 - \sum_{i=1}^{3} \alpha_i^n - \sum_{j=1}^{3} \sum_{i=1}^{3} \gamma_{ij}^n \log \frac{W_j}{P_n^R} - \sum_{i=1}^{3} \beta_{ik} \log K_n^r\right)$$

$$\text{Market Supply} = Q_n = \left(\sum_{r=1}^{5} p_r Q_n^r\right) \cdot H^R$$

Factor Demand functions:

$$X_i^{n,r} = \frac{\partial \pi^r}{\partial\left(\frac{wi}{P_n^R}\right)} = \frac{\pi_n^r}{W_i}\left(\alpha_i^n + \sum_j^3 \gamma_{ij}^n \log \frac{W_j}{P_n^R} + \beta_{ik}^n \log K_n^r\right)$$

$$X_i = \left(\sum_{r=1}^{4} \sum_{n=1}^{3} X_i^{n,r} p_r\right) \cdot H^R$$

Income

$$\text{Full income} = Y_r = W_L \cdot E_r \cdot T + \sum_{n=1}^{3} \pi_n^r P_n^R + \Theta_r$$

Demand

$$D_n^r = \left(a_n + b_n \log \frac{Y_r}{N_r \cdot P^R} + \sum_{m=1}^{5} g_{nm} \cdot \log P_m^r\right) \frac{Y_r}{P_n^R}$$

$$\log P^R = a_o + \sum_{n=1}^{5} a_n \log P_n^R + \sum_{n=1}^{5} \sum_{m=1}^{5} g_{nm} \log P_m^R \log P_n^R$$

$$D_n^R = \left(\sum_{r=1}^{4} D_n^r \cdot p_r\right) \cdot H^R$$

m,n index goods H, T, B as in production plus:

OG - other goods and Le - leisure

Urban Sector

Income (households indexed by u=1 to 4 for class membership)

$$\text{Full Income} = Y_u = W_L^u \cdot E_u \cdot T + \Theta_u$$

Demand

$$D_n^u = \left(a_n + b_n \log \frac{Y_u}{N_u \cdot P^Z} + \sum_{m=1}^{5} g_{nm} \log P_m^Z\right) \frac{Y_u}{P_n^Z}$$

$$\log P^Z = a_o + \sum_{n=1}^{5} a_n \log P_n^Z + \sum_{n=1}^{5}\sum_{m=1}^{5} g_{nm} \log P_m^Z \log P_n^Z$$

$$D_n^Z = \left(\sum_{u=1}^{4} D_n^u \cdot p_u\right) \cdot H^Z$$

Market Clearing Conditions

Paddy land allocation (for each class r):

$$\frac{P_H^R \cdot \pi_H^r \left(\Sigma \beta_{iK}^H \log \frac{W_i}{P_H^R} + \beta_K^H + \beta_{KK}^H \log K_H^r \right)}{K_H^r}$$

$$= \frac{P_T^R \cdot \pi_T^r \left(\Sigma \beta_{iK}^T \log \frac{W_i}{P_T} + \beta_K^T + \beta_{KK}^T \log K_T^r \right)}{K_T^r}$$

$$K_H^r + K_T^r = K^r \quad \text{(total paddy land)}$$

High Yield Rice market

$$Q_H = D_H^R + D_H^Z - M + A_H$$

Traditional Rice Market:

$$Q_T = D_T^R + D_T^Z + A_T$$

Barley Market:

$$Q_B = D_B^R + D_B^Z + I_B + A_B$$

Rural Labor Market:

$$\text{I.}\quad W_L = \bar{W}_L \qquad \text{(fixed wages)}$$

$$\text{II.}\quad X_L = (H^R \cdot T \sum_{r=0}^{5} p_r E_r) - D^R_{Le}$$

$$\text{III.}\quad V(Y_r, P^R) = V(Y_u, P^Z) \quad \text{for } r=0,\ u=1$$

Government Deficits

$$G_H = (P^R_H - P^Z_H + h_H) \cdot (D^Z_H - M) + (P^W_H - P^Z_H) \cdot M$$

$$G_B = (P^R_B - P^Z_B + h_B) \cdot (D^Z_B + I_B)$$

$$G_F = (P^O_F - W_F + h_F) \cdot (X_F + X^O_F) + (P^O_F + h_F) \cdot I_F$$

Variables (classified by first appearance in model)

Rural Sector

Production

π_n^r	Profit from crop n for a family in class r (in units of output)
W_i	Price of factor i in rural area
P_n^R	Price of commodity n in rural area
K_n^r	Land used in crop n by family in class r
Q_n^r	Production of crop n by family in class r
Q_n	Total Production of crop n
p_r	Fraction of rural households in class r
H^R	Total number of rural households
$X_i^{n,r}$	Demand for factor i by family in class r for use in crop n
X_i	Total demand for factor i in rice and barley production

Income

Y_r	Full income of family in class r
E_r	Number of working members of family
T	Total endowment of time (8760 hrs./year)
θ_r	Other income received by family in class r

Demand

D_n^r	Demand for good n by family in class r
N_r	Number of family members in class r
P^R	Rural Price Index
D_n^R	Total rural demand for good n

Urban Sector

Income

Y_u	Full income of family in class u
W_L^u	Wage rate faced by family in class u
E_u	Number of working family members in class u
θ_u	Other income of family in class u

Demand

D_n^u	Demand for good n by family in class u
N_u	Number of family members in class u
P^Z	Urban Price Index
D_n^Z	Total Urban Demand for good n
H^Z	Number of Urban Households
p_u	Fraction of Urban Households in class u

Market Clearing Conditions

M	Rice Imports
A_n	Waste and feedgrain use of good n
I_B	Inventory accumulation of Barley
V(.,.)	Indirect utility function

P_H^W	Price of rice imports
h_n	Handling cost per unit of n
P_F^O	Purchase price of fertilizer
I_F	Inventory accumulation of fertilizer
X_F^O	Use of fertilizer for purposes other than rice and barley cultivation
G_s	Deficit from commodity fund s

Endogenous Variables in Market Clearing Equations

π_H^r, π_T^r, K_H^r, K_T^r, D_H^R, D_H^Z, Q_H, D_T^R, D_T^Z, Q_T, D_B^R, D_B^Z, Q_B, X_L, Y^R, P^R, P^Z

W_L (labor markets II and III)

Exogenous Variables in Market Clearing Equations

K^r, A_H, A_T, A_B, H^R, $\bar{W}_L$ (labor market I)

Policy Instruments

P_H^R, P_H^Z, P_B^R, P_B^Z, W_F, M

Production

The production structure for all three crops (high yield and traditional rice, barley) is assumed to be characterized by a translog restricted profit function.

This form provides a quite general characterization of production when data is sufficient for complete econometric estimation. In addition, the flexibility of this functional form allows a priori information to be included conveniently when data is not available. For example, if the demand for fertilizer is known to be inelastic, this fact can be incorporated by increasing the parameter γ_{ff} (f referring to fertilizer) arbitrarily. In the Cobb-Douglas case, this possibility is not allowed at all. In the CES case, the assumption of inelastic fertilizer demand implies inelastic demand for all factors and incorporates quite strong assumptions about cross elasticities.

This functional form also lends itself to the analysis of two issues of particular interest in this project: farmer income generation and crop substitution. The rent accruing to the farmer is directly given by π_n when K_n^r units of land are owned. Total rent from land ownership, then, is $\sum_n \pi_n^r$ which can be added to wage and other income. This is the point at which the current study incorporates the insights of farm household models.

As for crop substitution, the assumption made is that for the period under analysis (a crop season) land is fixed to the farm but variable between uses. The only substitution which is explicitly modelled is between high yield and traditional rice. Both are included in the analysis, have the same growing season and use similar land. Barley is not a plausible substitute on the production side for rice (different growing season) and since the alternative uses of barley land are not explicitly modelled, an ordinary

barley supply function is adequate.

Land is assumed to be allocated between high yield and traditional rice use such that the value of the marginal product of land is equal across uses.

Since separate information on the production functions of the two rices is not available, the production functions will differ only by the shift parameter to α_o in the first pass of the simulations.

The above equilibrium condition, identical production functions and constant returns to scales imply a linear production possibility frontier between the two crops. The producer price ratio will be fixed in this case and equilibrium in the full model will require that traditional rice prices (left endogenous) will move in proportion to the subsidized price of high yield (See Figure 1).

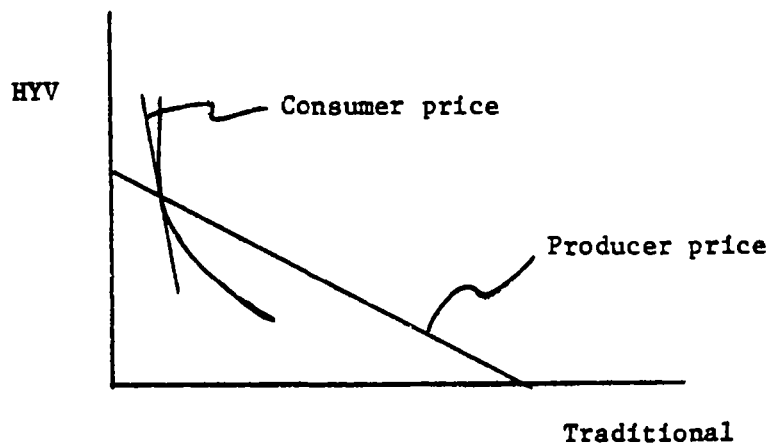


Figure 1: Production Possibility Frontier For Rice

Perfect substitutability between goods on the production side implies bang-bang behaviour for a typical farmer but not for the market as a whole (unless they are perfect substitute in demand or the indiffenence curves hit the axis). The strong implications of this linearity can be weakened by either

changing the β_{iK} terms between the two rices (changing the use of variable inputs alone does not affect the linearity) or by assuming decreasing returns to scale.

Consumption

The functional form for the system of demand equation to be used is the Almost Ideal Demand System of Deaton and Muellbauer. The form for a typical demand equation is:

$$\frac{P_i C_i}{Y} = \alpha_i + \beta_i \log \left(\frac{Y}{P \cdot N}\right) + \sum_j \gamma_{ij} \log P_j$$

P_i - Price of good i

C_i - Quantity purchased of good i

Y - Income of family

$P = \exp \left[\alpha_o + \Sigma \alpha_i \log P_i + \sum_i \sum_j \gamma_{ij} (\log P_i) (\log P_j)\right]$

N - # of household members

As written, this is also the estimating equation for econometric work.

This form has a variety of advantages for analyzing agricultural product demand in less developed countries. First, in contrast to other common functional forms for demand analysis such as the linear expenditure system (LES) the AIDS system is quite flexible with regard to price and income elasticities. Of particular interest in a disaggregated model including basic grains is the possibility of inferior commodities or commodities which are normal for low income consumers and become inferior at higher income levels. This possibility is ruled out by the LES system but wil generally occur in the AIDS case when $\beta_i < 0$ though not necessarily in the relevant range of incomes. This pattern of food use is frequently observed in disaggregate models. In the Korea context, barley is generally considered to be an

inferior good. Similarly, casual investigation of consumption of high yield rice suggests an inverted U shaped Engel curve.

Second, except for the price index generating real income, the AIDS system is linear in the parameters and therefore can be estimated with ordinary least squares (if symmetry is not imposed on the matrix of γ_{ijs}). The price index can be replaced by a simple Stone, expenditure share-weighted price index and estimated directly. This is a significant advantage if non-research oriented people are expected to carry out this analysis is the field.

Third, this demand formulation generally responds well in contexts where data is deficient. To improve the estimates in the face of data of questionable quality, instrumental variable estimation techniques will be used. Since the equation is linear and of simple form, this extra complication is easy to introduce.

Two different versions of the model can be run for a short-run analysis where migration between the two sectors is ruled out. In one, the rural wage is fixed exogenously. In this case, no explicit supply curve for labor need be computed from data. In the second case, a fully endogenous wage rate is generated by demand curves derived from the production structure above and supply curves derived from the consumer choice problem. To incorporate labor supply decisions into the analysis, the income term in the demand system should be the "full income" concept (after Becker). Explicitly, the per capita income of a farm household of type i can be written:

$$\frac{Y}{N_i} = \frac{W \times E_i \times T + \pi_{Ti} + \pi_{Hi} + \pi_{Bi} + Q_i}{N_i}$$

where E_i is the number of members in the labor force, T is the total endowment of time, π_{Ri} are profits from crop R, Qi is other income and Ni is

the number of family members. Farms are distinguished in this study by amount of land owned (landless; less than .5 to 1 ha, 1 to 1.5 ha, 1.5 to 2 ha, more than 2 ha).

With this definition of full income, the value of leisure (wage rate x leisure time) can be used in the demand structure above and leisure demand estimated. In the calculation of the impact of policy changes on incomes, both the impact on full income and on disposable or money income (full income minus the imputed value of leisure) can be computed. The latter may be more easily understood by policy makers and will involve more reasonable-looking numbers.

In the long-run model involving migration, the simple versions explored here will set the utility levels (consistent with the AIDS system) of the poorest groups in both sectors equal as an equilibrium condition. The equilibrium condition in this version is:

$$V(Y_u, P^Z) = V(Y_r, P^R) \quad u=1,\ r=0$$

where $V(Y, P) = \log (\frac{Y}{P})/(\beta_o \prod_{n=1} P_n^{\beta_n})$

Y = income of group

β_n = Income term in the AIDS System

P = Price index as calculated in the AIDS system.

Model Calibration

Given the structure of the model, the next task is to choose parameter values which will fit available information concerning the Korean economy for a base year. In this case the year chosen is 1979.

A great deal of information is known which is relevant to the model at hand. Unfortunately, since such information comes from many disparate sources, not all of it is completely internally consistent. The main reason for inconsistencies are the different types of data available (e.g. sample survey vs. aggregate figures), different years in which such information is available and, perhaps most importantly, the fact that the model is not a perfect and exact representation of the underlying reality. Since the true production function is not exactly a translog production function (the claim made is merely that the latter is a close approximation to the former) we cannot expect this function, regardless of the parameters chosen, to exactly reproduce observed values. The purpose of the calibration exercise, therefore, is to combine all of these various bits of information into a consistent framework.

The main types of information to be incorporated are: 1) Aggregate MAF and national account statistics, such as total area and production of crops or urban per capita incomes 2) Information from the Farm Household Economy Surveys which are reported in group average (e.g. by farm size) but which are not analyzable at the household level. Average farm income and land ownership patterns are derived from this c) Survey data in original form which is suitable for formal econometric estimation. This source of data may be rare in many countries but in Korea, the rural household survey of 1970 was available. A detailed description of the estimation procedure used is presented in the following section. d) A priori judgement concerning key behavioral patterns such as demand or supply elasticities or substitution possibilities between goods (in demand) or land (in supply). Since so much information from other sources was appropriate, little reliance was necessary on these external judgement. In countries where data is scarce, such judgements will be more important, e) Goverment records on actual prices

charged or quantities transacted in official channels.

The calibration tries to stay as close to the above information as possible without violating the requirements of the model. These requirements are of two forms. The first is simply that all equations of the model hold. All market clearing equations must be satisfied and all production and demand equations must be satisfied for the levels of income, prices, land area etc. used in the model.

The second type of restriction on the values of parameters and variables result from requirements of the functional forms chosen and common sense. While the translog production function and the AIDS demand system are flexible characterization of behavior, they have one important drawback. For a given set of parameter values, they are not guaranteed to be "well behaved" for any arbitrary set of prices (or incomes in the AIDS case). Thus, while they are good "local" approximation to the underlying function they need not satisfy the requirements of demand or production theory globally. In particular, if estimated from survey data, the demand system may violate requirements of theory for the data in the base year used for calibration. The second set of requirements, then are those which assure that the demand and supply systems conform to the basic requirements of theory in the base year. These are 1) Non negatively of quantities. More from common sense than from theory, implied levels of production and consumption must be positive 2) Convexity requirements from theory. The implicit cost function for the translog production structure must be concave in factor prices and the expenditure function of the AIDS system must be concave in commodity prices.

Given the goal of matching base year numbers with a well behaved set of demand and supply relations, the approach takes is related to Bayesian decision theory and takes the form of solving the following optimization problem:

Minimize with respect to X_is $\quad \Sigma a_i((X_i - \bar{X}_i)/\bar{X}_i)^2$

subject to

1) all model equations are satisfied
2) all theoretical restrictions on parameters are satisfied
3) all values known with certainty are set

The X_i's can be parameter values of the demand or supply system, functions of those parameters (such as price or income elasticities for a particular income group) or quantities in the base period which are not known with complete certainty (such as prices in uncontrolled markets or the relative proportion of paddy land in high yield variety versus traditional rice).

The $\bar{X}_i$'s are the values the X_i's are expected to take given the various sorts of information discussed above. We would like the final result to be as close to these independently observed values and proportional deviations from these values are penalized. The X_i's may be actual, econometricaly determined parameters such as the γ's in the supply or demand system, they may be elasticities of demand or supply from either these estimates or from prior beliefs or they may be values of quantities or prices from questionable sources (such as, for example, a rudimentary survey of prices designed to get only approximate estimates).

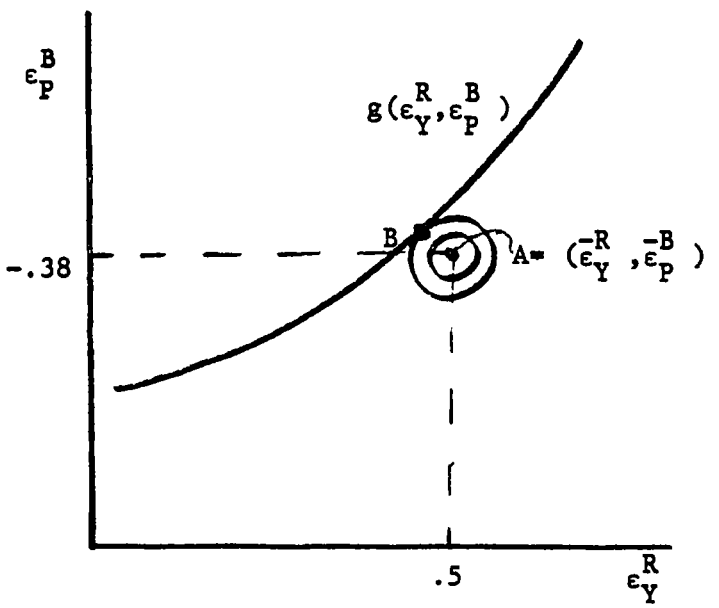
The a_i's are weights which reflect the degree of confidence we have in these starting values, the $\bar{X}_i$'s . If, for example, we are quite sure of the price elasticity of barley for the average rural consumer but not so sure of the relative consumption of HYV rice to traditional, the former term would have a larger value of a_i than the latter.

The restriction to ensure a well behaved system in the base period are a) all quantities are positive b) all marginal products of factors of production are positive c) the Slutsky matrix $[S_{ii}]$ of the demand system has negative diagonal elements, that is

$$0 > S_{ii} = \left(\gamma_{ii} + \beta_i^2 \log \frac{Y}{P} - \frac{P_iQ_i}{Y}\left(1 - \frac{P_iQ_i}{Y}\right)\right) Y/P_i^2$$

for all commodities i and all income groups in the base period. This is a necessary, but not sufficient condition for a well behaved demand system. The sufficient condition (that the Slutsky matrix be negative semidefinite) was too difficult to impose directly but was checked after the calibration run.

To illustrate how this method works, a simple example is presented in the following diagram



Calibration Technique Example

In this case, two parameters of interest are separated from the rest of the model for graphical convenience, the price elasticity of barley for the average rural income group (ε_p^B) and the income elasticity fo rice for, say, the richest rural group (ε_Y^R) . The curve $g(\varepsilon_p^B, \varepsilon_Y^R)$ represents the combination of these values which will satisfy the remainder the model, given quantities consumed, incomes, prices, the AIDS functional form, etc. For the model to work, we must choose a point on this curve for our parameter values.

The point A represents the values of these parameters we would most like to have for our base period. They might have come from econometric estimate which yielded a price elasticites of -.38 for barley and an income elasticity of .5 for rice. Since these values are not consistent with the rest of the model (not being on the function g (.,.)), another point which is on this functiom must be chosen. The points on the concentric ellipses are equidistant from the point A, given a set of weights a_i. If the weights are equal, the ellipses will be circles. The parameters which generate the elasticities at point B would be the one which this method would choose for the model. These values would satisfy all the requirements of the model (being on the function g (.,.)) and requiring the smallest degree of modification to the values which are known from independent sources (being the "closest" point to our reference A).

APPENDIX C

Parameter Estimation

Parameters in the consumption and production relations in the model were calculated by two different methods. The MAF regularly collects survey data from rural areas. This data was sufficient to formally estimate production functions and a system of demand function with econometric methods. The estimation procedure and results are outlined in this section. The other method, which requires much less information, is briefly discussed and contrasted with the more complete procedures.

Production

The estimating equations for the translog restricted profit function are the factor demand equation written in share form. Two issues come up in the context of the estimation. The first is the restrictions which can be imposed on the parameter values to incorporate assumptions or requirements of production theory. The second is problems arising from the use of survey data.

From production theory, the matrix of substitution term should be symmetric, i.e., the coefficient of the wage term in the fertilizer equation should be the same as the fertilizer coefficient in the labor demand equation. This restriction requires iterative estimation techniques rather than ordinary least squares. The second restriction (more a matter of choice than a requirement of theory) is that the production process for grains be subject to contstant returns to scale. If all inputs, including land, were doubled then output would double as well.

The only product for which complete price and output information was available was the aggregate commodity rice. Separate information was not

available for HYV and traditional rice. The inputs used for estimation purposes were: labor, organic fertilizer, inorganic fertilizer, animal inputs, pesticides and others. As described in Appendix B only the inorganic fertilizer and labor terms are used in the simulation. The remaining inputs are used to get consistent estimation of the paramaters of interest.

Survey data relies on the recollection of the farmer concerning quantities of the various factors used and the expenditure on them. Since both of these quantities are subject to error and since the independent variables (prices) are derived by dividing expenditures by quantities, the measurement of these variables are necessarily subject to error. This could introduce bias in the estimates. To correct for this, instrumental variables are used in the estimation. With constant returns to scale and symmetry of production parameters imposed and instrumental variable techniques, the following equations were estimated:

$$\frac{W_L \cdot X_L}{\pi} = \underset{(.026)}{.332} + \underset{(.100)}{.174} \log \frac{W_L}{P_R} + \underset{(.021)}{.018} \log \frac{W_F}{P_R}$$

$$+ \underset{(.005)}{.033} \log \frac{W_O}{P_R} - \underset{(.063)}{.150} \log \frac{W_A}{P_R} + \underset{(.017)}{.017} \log \frac{W_P}{P_R}$$

$$\frac{W_F \cdot X_F}{\pi} = \underset{(.005)}{.072} + \underset{(.021)}{.018} \log \frac{W_L}{P_R} + \underset{.011}{.021} \log \frac{W_P}{P_R}$$

$$+ \underset{(.010)}{.011} \log \frac{W_O}{P_R} - \underset{(.013)}{.017} \log \frac{W_A}{P_R} + \underset{(.003)}{.005} \log \frac{W_P}{P_R}$$

standard errors in parentheses.

W_i = Price of factor i

X_i = Quantity used of factor i

i = L: Labor

= F: Chemical fertilizer

= O: Organic fertilizer

= A: Animal inputs

= P: Pesticides

π = Profit in rice

The only parameters left to be chosen are the average profit terms, the α_o's of the profit function. These were chosen for HYV and traditional rice in order to match actual profitability figures for 1979. This is the only way in which the two strains differ.

Statistical tests reject the hypothesis that the independent variables are free of measurement error [1/] justifying the use of instrumental variable estimation. Statistical tests also reject the hypothesis that the production structure is Cobb-Douglas. This would require that all coefficients on prices are zero. The essential difference is that the estimated production function exhibits somewhat smaller elasticities of substitution between inorganic fertilizer and labor than the Cobb-Douglas form would allow. It also implies less elastic factor demands. However, in the simulation model the estimated production structure had little effect on the results. Assuming a Cobb-Douglas form makes the choice of parameters much easier. In this case, average shares of output spent on each input is sufficient. This information needn't come from survey data, regional even national level data is adequate.

The supply elasticity implied by the above estimates is between .37 and .52 for the translog and Cobb-Douglas versions. This cross-section, survey-based assessment was validated by an aggregate, time series estimation of a

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[1/] See J. Hausman "Specification Tests in Econometrics."

"Nerlove" type [2/] using MAF annual statistics. In this simple estimation, the supply elasticity with respect to price was found to be .42. This is within the range used in the simulation and provides independent confirmation of the parameter values used.

Demand

Demand equations are subject to essentially the same problems as supply. The issues of symmetry and errors in variables are identical and treated in the same way. The only extra constraint imposed on the estimation is that the labor supply is fixed. This requires that "leisure's" share of full income is independent of the prices of all goods. The resulting equations for rice and barley are:

$$\frac{P_R Q_R}{Y} = \underset{(.012)}{.307} - \underset{(.001)}{.033} \log \frac{Y}{P \cdot N} + \underset{(.005)}{.017} \log P_R \; \underset{(.0002)}{-.0002} \log P_B - \underset{(.002)}{.001} \log P_O$$

$$\frac{P_B Q_B}{Y} = \underset{(.005)}{.126} - \underset{(.005)}{.013} \log \frac{Y}{P \cdot N} - \underset{(.0002)}{.0002} \log P_R + \underset{(.002)}{.006} \log P_B + \underset{(.0007)}{.001} \log P_O$$

Standard errors in parentheses

P_R, P_B, P_O - Price of rice, barley, other foods

Q_R, Q_B - Quantity consumed of rice, barley

Y - Price index (cost of living)

N - Family size

2/ See Cumming and Askari, Agricultural Supply Response: A Survey of the Econometric Evidence, (New York, Praeger, 1976).

As with the production parameters, the above estimates imply that demand for rice and barley are less elastic than unity. At the mean of the sample, the price elasticity for rice is .63 and for barley .38.

The income effects (both negative) imply that consumption declines as a share of income as income rises. In fact, both rice and barley become inferior goods at the high end of the sample income distribution. The Engel curves for these commodities have the following shape (see figure 2), commonly found for foodstuffs:

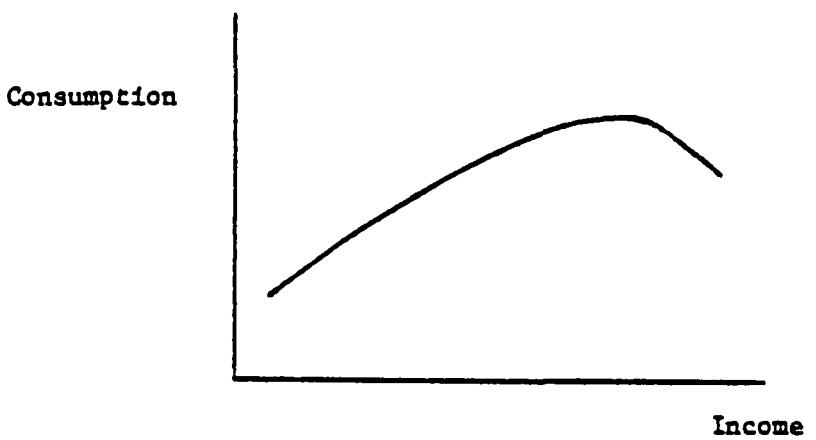

Figure 2 Engel Curve for a Typical Food Product

Again, as with the production estimates, the test of errors in variables implies that measured error is a problem and justified the use of the more complicated instrumental variable techniques. In contrast with the production case, however, the difference between the estimated version of the demand system and its Cobb-Douglas simplification (all own price elasticities equal to 1) was substantial when included in the simulation model. The simplified

parameter values entailed setting all price effects in the above relation equal to zero. Aggregate consistency was achieved by choice of the income terms. With a known income distribution and known consumption patterns for urban and rural consumers, values for the mean share and the income term may be identified.

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LC 74-15210. ISBN 0-300-01815-0, $15.00 hardcover; ISBN 0-300-01877-0, $3.95 paperback.

Spanish: Investigación agrícola y productividad. *Editorial Tecnos, 1976.*

ISBN 84-309-0641-X, 420 pesetas.

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French: L'Analyse des projets agro-industriels. Economica, 1982.

ISBN 2-7178-0480-3, 49 francs.

Spanish: Análisis de proyectos agroindustriales. *Editorial Tecnos, 1981.*

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World Bank (EDI), March 1974; revised January 1975. 480 pages (Available from ILS, 1715 Connecticut Avenue, N.W., Washington, D.C. 20009, U.S.A.)

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The Johns Hopkins University Press. 1982. 145 pages. French and Spanish forthcoming.

LC 82-7126. ISBN 0-8018-2910-0, $8.50 (£6.50) paperback.

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EDI Series in Economic Development.

The Johns Hopkins University Press. July 1982. 528 pages (including appendixes and glossary/index).

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