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Introduction

Most of the world's poorest live in rural areas. They derive a large share of income out of agriculture, as small farmers or as workers—or, as both. Agricultural development is therefore often seen as the key to reducing poverty, especially rural poverty. In most of Sub-Saharan Africa, for example, where the rural poor are mostly small farmers, it is clear that increasing the efficiency of these farmers vis-a-vis large farmer grou (or of the country as a whole vis-a-vis competing countries) improves the small farmers' condition. They can expand their sales and/or can produce their own subsistence with less effort or less cash costs (for a full discussion see World Bank, 1986).

When the poorest rural groups are landless, as in South Asia, the issues are much more complicated. Small farmer-oriented strategies still help an important segment of the poor population to improve their competitive position. However, agricultural development measures do not affect the welfare of workers directly but only via the impact they have on the demand for labor and on the level of output prices. Agricultural development measures enhance efficiency of resource use. Therefore they normally reduce labor input per unit of output. How much they reduce it depends on the source of productivity gain. The reduction is larger for machines than for added irrigation, for example. Labor demand can only rise if the enhanced profitability of farming leads to an output increase which is sufficiently large to compensate for the initial reduction in labor requirements. The output expansion depends on the nature of the demand for agricultural output and on the elasticity of supply of agricultural output. The demand for agricultural output is price elastic for small open economies, but inelastic for closed or state trading economies. In closed economies the income effects of agricultural development and the income elasticities will condition the demand side along with the price elasticities. If output expansion is sharply limited from the demand side, agricultural growth will lead to reduced agricultural labor demand, but sharply lower food prices. The poorest rural group would lose as workers but gain as consumers. Which effect will be more important?

In this paper we use a general equilibrium model of India's agricultural sector to ask how much the poorest rural group can gain from agricultural development measures once output price and employment effects are accounted for. We first examine what happened to the income of different income groups during the last two decades of very successful agricultural growth. We then explore technical change in different crops under alternative trade assumptions, and consider the effects of expanding irrigation, declining fertilizer prices and removing trade restrictions on rice. The results suggest that consumer benefits are more important for the welfare of the largely landless than employment effects, and that they can benefit very substantially from agricultural growth only if food prices decline. This raises difficult policy dilemmas because declining prices erode the gains of the rural sector as a whole. We therefore explore food rations and direct income transfers as alternative ways to assist the poverty groups.

I. A Summary of the Model

The limited general equilibrium model for our investigation determines quantities and prices in seven markets: three input markets (labor, draft power, and fertilizers); and four agricultural output markets (rice, wheat, coarse cereals, and other crops). [A mathematical exposition of the model can be found in Quizon and Binswanger (1986).]. The model also determines residual farm profits. Given these prices and quantities, it then determines the real incomes of four rural and four urban income quartiles (R1, R2, R3, and R4 and U1, U2, U3, and U4, respectively).

The supply of the four agricultural commodities and the demand for the three factors of production are modeled as a jointly estimated system of output supply and factor demand equations. Output supply and factor demand shift in response to changes in exogenous endowment and technology variables: land (cultivable area), annual rainfall, irrigation, high-yielding varieties, roads, farm capital (animals and implements), regulated markets, and technological change.

The supply of labor is responsive to the real rural wage. Agricultural labor is supplied by rural groups and also by some urban emigration, which is responsive to the rural wage.

The supply of draft power is responsive to the real rental rate for draft animals and is supplied by each of the rural groups.

The fertilizer supply is treated as an aggregate of nutrient tons, which is responsive to the price of fertilizer relative to nonagricultural goods prices.

The supply of land is exogenously given as the cultivated area. This treatment still allows cropped area to vary endogenously via changes in the extent of double and triple cropping. And, of course, the area allocated to different crops can vary. While the supply of land is exogenous, net returns to land (the residual farm profits after variable factors have been paid) are determined endogenously.

Consumer demand is responsive to the prices of commodities and the real income of each of the eight income groups. Poorer groups have higher income elasticities than richer groups. Each income group's demand must therefore be modeled separately. Demand was estimated econometrically; a flexible functional form was used, so that all (compensated) cross-price elasticities were directly estimated. Aggregate demand is the sum of the demands of all the income groups.

Nominal income is computed as each group's supply of agricultural production factors multiplied by the factor prices, plus an exogenously given component for nonagricultural income. Real income is calculated for each of the eight groups as their nominal income deflat d by an endogenous consumer price index that is specific to that group's consumption patterns and reflects all endogenous changes in food prices.

Prices and quantities of commodities and factors of production are determined as those which equate aggregate supply and demand in each of the seven markets. The government can influence agricultural prices through the use of tariffs, food imports and exports, food grain storage, forced procurement at fixed prices, and sales in consumer ration shops at nonequilibrium prices. The model solves simultaneously for changes in endogenous prices and quantities and thus determines for each income group the change in its nominal income, price deflator, real income, labor supply, draft power supply, and level of consumption.

Nonagricultural prices are given exogenously and are used as the numeraire of the model. Because nonagricultural income is also given, nonagricultural production is exogenous and consumption of this output must adjust via trade.

The base year used in constructing the model is 1973-74. Initial values are computed largely from an extensive rural household survey by the National Council for Applied Economic Research.[1/] The entire model is written in logarithmically linear equation form.

There are several characteristics of the model which must be kept in mind while interpreting our findings. First, it is well known that the distributional outcomes from general equilibrium models depend crucially on labor market assumptions (Taylor, 1979). We model the real rural wage by equating supply and demand for labor; that is, it is a full employment model. This treatment is consistent with the empirical evidence that there is little year-round unemployment in rural areas and that most unemployment is seasonal (Krishna, 1976). Moreover, real wages are variable both within and across years; that is, no model of constant nominal or real wages is consistent with the data. Econometric studies of labor demand (Evenson and Binswanger, 1984) and supply (Bardhan, 1984; Rosenzweig, 1984) are also consistent with our equilibrium treatment of the rural labor market.

The model treats nonagricultural incomes (and implicitly urban wages and nonagricultural output) as exogenously determined. The purchasing power of the nonagricultural incomes, however, depends on agricultural prices. When these prices rise, urban agricultural demand will fall because of both price and income effects. But other feedbacks from

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1/ For a fuller discussion of data sources and estimation of parameter values, see Appendix B and Pal and Quizon (1983).

agricultural activity to the nonagricultural sector are not allowed for in the model. One consequence of our treatment of the nonagricultural sector is that changes in food prices have no effect on the nominal urban wage; that is, reductions in food prices benefit urban wage earners and are not passed along to employers in the form of lower wages.

Although the model determines what happens to real farm profits and the incomes of the rural income groups, it does not treat endogenously what subsequently happens to private savings and private agricultural investments brought about by the changing fortunes of farmers. Thus our model is not a very long-run model. The reason for this treatment is that no econometric study exists which quantify the link between farm profits and farm investment.

Finally, the model omits the effects of the market for foreign exchange on agricultural performance, and vice versa. India is modeled as a state-trading economy in which decisions to export or to import agricultural commodities rest with the government. These decisions are exogenous to the model.

Results from counter-factual analysis of the period 1960 to 1980 are reported in Quizon and Binswanger (1986). From our counter-factual analysis we note that our model is able to reasonably trace the major trends in Indian agriculture over the two decades 1960-61 to 1980-81.

II. What Happened to Rural Incomes During the Green Revolution?

Longitudinal data on rural incomes, its components such as farm profits or its distribution, do not exist for the period 1960 to 1980. The model's equations can, however, be used in an accounting mode to generate time series of rural incomes. We generate the income series for each of our

8 income groups by using actual estimates of agricultural output, agricultural prices, wages and fertilizer consumption, as well as the exogenous variables that affect the income and factor market equations in the model. The numbers in Table 1 are indexes of the predicted levels and are calibrated so that the predicted level of each variable is equal to 100 for 1970-71, the end of the first phase of the Green Revolution.

We assumed that during the twenty-year period the across-quartile shares in ownership of factor inputs and within-quartile shares of nonagricultural and factor incomes in total income remained equal to their respective base-year (1973-74) values. We also assumed that the rates of growth in the population, in the agricultural capital stock, and in the nonagricultural income of each quartile were the same across the groups. Although the total endowments of the various groups change over time, the relative endowment position of each group was assumed to remain the same. But there may have been other causes of change in actual incomes that we were unable to account for, such as changes in taxation, in investment behavior, in people's occupations, and in food subsidies. Table 1 shows what would have happened to real income as a result of changes in agricultural production and technology, agricultural output and input prices, nonagricultural incomes and prices, and population.

The last two rows of Table 1 show the actual growth of total agricultural output and the change in agricultural terms of trade. Agricultultural production grew rapidly during the early Green Revolution period (1965-66 to 1970-71) and again from 1973-74 onward. Agricultural terms of trade rose prior to the Green Revolution, stayed fairly constant until 1973-74, and then dropped substantially by 1980-81.

These changes in quantity and price explain the changes in farm profits. Farm profits were depressed in 1960-61 and in 1965-66 but then moved dramatically upward by 1970-71. By 1973-74 they had declined to 85 percent of their 1970-71 level, and by 1980-81 to 76 percent of the 1970-71 level. In these years, declines in output prices outweighed rapid growth in agricultural output.

Employment in agriculture (estimated in our model) grew by about 20 percent during the twenty-year period. Because real wages declined by about 5 percent, the total real wage bill for the period rose by about 15 percent. Nonagricultural real income more than doubled during the period, with the most rapid increases occurring just prior to the Green Revolution and between 1975-76 and 1980-81.

The trends in output and factor prices, and in agricultural and nonagricultural income, suggest that real aggregate per capita income among rural people grew by only about 8 percent during the early stages of the Green Revolution, after which it declined and stagnated. Despite a drastic shift in the distribution of rural income from wages to profits in the early period, rural income distribution was remarkably stable for the period as a whole. The effect of adverse wage trends on the rural poor was partially alleviated because agricultural employment increased somewhat and because the poor participated to a small extent in the growth of farm profits. About 11 percent of their income was derived from such profits. They also had substantial gains in nonagricultural incomes, and as consumers they benefited from the decline in agricultural prices during the last five years of the twenty-year period.

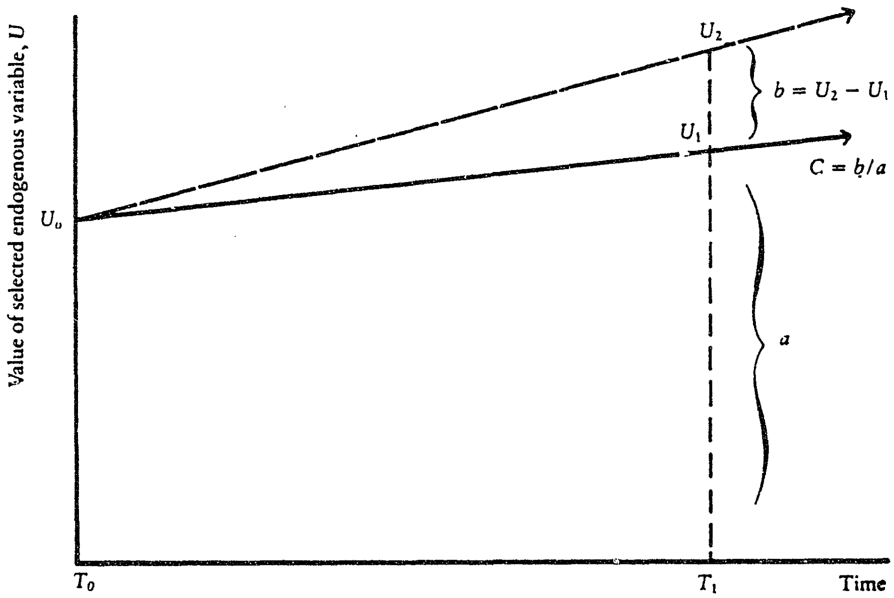
The first period of the Green Revolution was one of substantial gains in farm profits. But the rapid gains in production during the late 1970s did not translate into further advances in income because the prices of agricultural products fell. The production gains from the early Green Revolution period were associated with rising prices because the government used the gains largely to replace imports. But once self-sufficiency in food grain production was more or less assured, the surplus grain production had to be absorbed domestically. This was a classic example of the process in which productivity gains in agriculture were transmitted to consumers (both rural and urban) by way of declining prices. In the late 1970s the combination of rapid nonagricultural growth and declining agricultural terms of trade greatly benefited the urban groups. The biggest beneficiaries were the urban poor since they spend a larger share of their incomes on food.

III. How Can Sector-Specific Policies and Programs Help the Rural Poor?

The previous section offers only partial explanations as to why wages, farm profits, and income distribution evolved the way they did. An assessment of how each individual change in a policy or a trend affects the rural poor is required to separate out the influences of the different factors.

We do this by comparing the results of a simulated change in selected trends or policies with the "base case". Thus we simulate a change in a specific exogenous variable, such as technology, and trace the effect of the change on production, prices, employment, and farm profits. This then allows us to compute how real incomes would have been affected. Figure 1 illustrates this process. U_0U_2 is the path of the specific endogenous variable given actual policy trends and events, and "a" is the value of U at

Figure 1 *Simulated Changes in Trends and Policies: Derivation of Values*



Note: C = percentage change in simulated value of *U* from its "base" trend value, as the result of a simulated change in one or more exogenous variables. *C* values are those shown in tables 3 through 6.

U_1. The variable U could be one of those shown in the column headings of tables 2 and 3. U_0U_2 is the simulation path of U if an exogenous change or intervention occurred, such as any of those shown in the left-hand column of tables 2 and 3. The value b is the difference between U_2 and U_1, the induced change in U at T_1; and C is the percentage change in U, or b/a. T_0 to T_1 is perhaps three to five years, sufficient time for farmers to respond to changes in technology, policies, and prices by adjusting their production patterns.

For the technical change scenarios of table 2, yields of an individual crop or a crop group are assumed to rise by 10 percent, a change corresponding to a substantial varietal shift.[1/] We show results for

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1/ For a detailed discussion of how technical change is introduced in the model, see Appendix III of Quizon and Binswanger (1984).

technical change in rice alone, in coarse cereals alone and for all crops taken together. Because the share of rice in total crop output is much larger than that of coarse cereals, (27 percent versus 11 percent), a 10 percent yield gain has more powerful effects if it occurs in rice rather than in coarse cereals. And technical change in all crops is more powerful yet. The two other development measures considered are an expansion in irrigation by 10 percent and the provision of a 20 percent subsidy to fertilizer consumption.

The technical changes are explored under two different trade regimes. In the first regime (scenarios 1, 2, and 3) the economy is considered closed and additional production is consumed in India. But in the second regime (scenarios 6 and 7) a fraction of the extra yield is either exported or used to reduce imports of the commodity in question. The fraction of the extra yield which is exported is set such that the GNP deflator (not the individual commodity prices) is stabilized. Note that scenarios 6 and 7 correspond to an assumption of state trading; it is not an open economy model with trade in many commodities.

When an increase of 10 percent in rice yields has to be absorbed domestically, the result is a sharp decline in the price of rice (-15.5 percent) and in the price of its closest substitute, wheat (-10.6 percent). Rice production increases by about 10 percent, while wheat production declines by about 3 percent. (For these details see Quizon and Binswanger, 1986). The GNP deflator (measured in terms of nonagricultural commodities) therefore declines by about 6 percent, while total agricultural output increases by about 2.7 percent. The price decline and the increase in agricultural output imply a real national income gain of about 2 percent.

The increased agricultural output requires only moderately larger labor inputs, and the increased demand for labor results in modestly higher real agricultural wages. Therefore the real wage bill rises by a mere 1.3 percent. The declines in agricultural prices, combined with the rise in wages, lead to a reduction in residual farm profits despite the increase in agricultural productivity. The price effects, the farm profit effects, and the wage largely explain the distributional outcome. Net buyers of food gain, and the more so the larger is their share of income spent on food. The urban poorest gain the most (6 percent). The rural poor also benefit, since they also spend most of their income on food. Moreover, they benefit from the slight rise in wage levels. Since reduction in farm profits affects them only slightly, they end up with a net gain in real income of close to 4 percent. However, since the rural rich derive much income from farm profits, their gain as consumers is not sufficient to offset their loss in profits. Their real income therefore falls by 0.7 percent.

A decision to maintain the price level by exporting a portion of the expanded rice production (scenario 4) would sharply alter the distributional outcome. Farm profits rise by 8 percent and therefore the rural rich are the main gainers. Their income expands by 3.7 percent. The added demand for commodities with high income elasticities implies that relative prices must change in order to maintain overall price stability. The rice price then declines by 9 percent, leaving the urban poor with a gain of only about 0.8 percent. The rural poor gain only 2.1 percent, less than with domestic absorption. Their consumption gain is eroded since additions to their wage income or farm profits are not sufficient to offset the consumer losses.

The sharp effects of trade on income distribution are also evident in the other technical change scenarios, although magnitudes and other details differ significantly by commodity. Except in the case of coarse cereals, the gains of the urban poor groups are larger than those of the rural poor when the extra output caused by technical change is absorbed domestically. (In the case of coarse cereals, the gains of the rural poor exceed those of the urban group because urban consumers buy very little coarse cereals). As the all-crop scenarios illustrate, trade policy is the major determinant of the distributional outcome of technical change. With domestic absorption the urban poor gain as much as 17.8 percent. When trade is used to stabilize price levels their gains are eroded to a mere 2.2 percent. For the rural rich the impact of trade is equally dramatic. With no exports their gains are only 1.8 percent. With stable prices they gain nearly 15 percent.

The rural poorest gain nearly twice as much under domestic absorption than under price stability. When prices are stable they gain a little as consumers, a little as farm workers, and a little from higher farm profits in which they have a very small share. The only group who is hardly affected by trade policy changes is the small farmers whose consumer gains buffer producer losses and vice versa.

Finally, it is easy to completely erode the gains of the rural poor from technical change by more aggressive export-oriented policies which lead to increases in domestic prices [Quizon and Binswanger (1986), table 3]. More aggressive export policies have a sharply regressive impact since they provide large benefits to the rural rich and hurt the urban poor.

Irrigation Investment

In row 4 of table 2, the assumption is that investment in irrigation is accelerated enough to increase the percentage of area irrigated by 10 percent. This leads to an increase in aggregate output of 2.7 percent and a decrease in the aggregate price level of 5.8 percent. Because irrigation requires labor, labor employment and real wages rise slightly. However, this labor demand effect on irrigation is not very large because inelastic final demand curtails the expansion of output. Residual farm profits, therefore, decline by 4.8 percent as a consequence of slightly higher labor costs and lower output prices associated with domestic absorption. The income distributional outcomes follow from these changes in price and profit. The landless gain modestly (2.9 percent), while large farmers lose (-0.7

percent). All urban households gain substantially, with the poorest showing the largest gain (6 percent). Qualitatively the results are similar for expansion of marketing infrastructure and private capitals (see Quizon and Binswanger, 1986).

Fertilizer Price Decline

Declines in farm gate prices of fertilizers can occur in several ways. The government could eliminate the import tax now levied as part of its program of subsidizing and protecting domestic production of fertilizers. Or, for the given protection level of the domestic industry, it could reduce the farm gate price by increasing its financial subsidy to farmers. In the simulation reported in table 2, we do not fully model the effects of the implied changes in government revenues, or the effects on the domestic industry.[1]

1/ For a more complete analysis of fertilizer policy see Quizon (1985).

The poorest rural group loses with lower fertilizer prices because, with inelastic final demand, fertilizer acts as a substitute for labor and the real wage bill declines by 1.3 percent. For the poorest rural group the negative wage effect dominates the benefit from reduced output prices while the reverse is the case for the second quartile in which farm profits are a larger share of income. Farm profits rise sharply on account of both lower fertilizer and lower wage costs. Therefore fertilizer price declines benefit primarily the large farmers.

Liberalizing the Rice Trade

The agricultural development alternatives considered so far can have a substantial benefit for the rural poor only if they result in price declines. This recognition lies behind India's consistent anti-trade bias in agriculture, and has resulted in domestic staple food prices being generally held at or below world market prices during the 1970s and early 1980s. The price differences have been particularly marked for rice.

We compared prices in two major producing states of India with world rice prices, i.e., the price of Thai 5 percent brokens (f.o.b. Bangkok), for the same period. In the period 1963 to 1972, Indian domestic rice prices averaged about the same level as world rice prices. But for the period after 1972, domestic prices have been significantly below world prices. This difference has been as large as 55 percent and has remained high. In the simulations we will assume that the domestic rice price is 70 percent of the world rice price prior to the opening of India to free trade in rice. Wheat prices were far less depressed compared to international levels [Quizon and Barbeiri (1985), tables 1 and 3].

An anti-trade policy in rice clearly hurts the rural sector as a whole. And because rice is a labor-intensive crop, it may even hurt the rural workers if expanding rice production had a large effect on the real wage bill. This issue is explored in Quizon and Barbeiri using a special version of the basic model; the results are shown in rows 8 and 9 of table 1.

The world rice trade has always been small, particularly when compared to India's own rice production. Annual world gross exports of rice averaged only 11.24 million metric tons (m.m.t.) for the period 1978-80,whereas India's own rice production was 49.74 m.m.t. for the same period. Therefore, even if India exported only a small percentage of her rice production, say 5 percent or 2.49 m.m.t., this alone could depress world prices, given that the world demand for and the world supply of rice exports are fairly inelastic. Evidently, the amount of rice India can trade is restricted by the size of the world rice market. In later simulations, we assume gross world exports of rice to be 9.60 m.m.t., the annual average for 1976-78.

Although the international rice market has been dominated by government-to-government contracts and long-term trade agreements, different empirical studies still suggest varying degrees of responsiveness of international rice supplies and demands to the world price. Whereas Falcon and Monke (1979-80), for example, conclude that the price mechanism is important in clearing the world rice market, Siamwalla and Haykin (1983) show that the role of prices, though positive, is extremely limited. Existing empirical evidence, however, agrees that the demand for and supply of rice exports are fairly inelastic, i.e., both α_W and ε_W are less than one. In later simulations, we assume two extreme sets of elasticity values. The firstset of elasticity estimates, i.e., $\alpha_W = -.08$ and $\varepsilon_W = .14$, are a lower bound and correspond to Siamwalla and Haykin's (1983) estimates of the world demand and supply elasticities for rice for the year 1980. The second set of estimates, i.e., $\alpha_w = -.87$ and $\varepsilon_W = .55$, are much higher. These correspond to the price elasticities of demand and of supply for rice in India which we estimated and used in our model.

The results show the large impact which India could have on the world rice price; even under the high elasticity assumption would drop by about 21 percent, while Indian rice exports would amount to a mere 2.85 percent. India's rice prices would rise by about 12 percent, curtailing domestic demand. Therefore domestic production would rise by only 2.6 percent. Moreover, these increases would come at the expense of a reduction in coarse cereals of 3.3 percent and of other crops of 0.6 percent. Aggregate agricultural output would rise only by 0.3 percent. With inelastic world supply and demand the aggregate domestic output effects decline to less than 0.1 percent.

Because the impact on domestic output is so limited, there is very little impact on the labor demand and the real wage bill. Therefore the price effects dominate and the welfare of the rural poorest declines, while the second quartile experiences virtually no change in its welfare level. The gainers are the rural well-to-do, who gain more the higher the elasticity of world demand and supply of exports.

For the rural poor to gain from open rice trade, the additional income of the rural rich would have to have powerful effects on the nonfarm economy via consumption linkage, which are not explicitly modeled here. In the absence of empirical estimates of consumption linkages, it is not possible to assess whether such trickle-down effects would be sufficient to offset losses of the poor modeled here.

Despite our conclusion that free trade in rice would hurt the rural poor, a simple simulation shows that if world elasticities are high, India has foregone significant arbitration opportunities in international markets during the 1970s and 1980s. With international rice prices exceeding wheat prices, India could have exported small quantities of rice in exchange for additional wheat imports. In scenario 10 we model the domestic impact of selling 0.5 million tons of rice and trading it in for 0.93 million tons of wheat, using 1978-81 international rice and wheat prices adjusted for the relevant transport costs. Because wheat and rice are substitutes in domestic consumption, the additional wheat quantities depress both domestic wheat and rice prices, although the rice price falls far less than the wheat price. National income rises by 0.7 percent and the incomes of all groups, except the large farmers rise. While the rise for the rural poor is a very modest 0.08 percent, it is significant relative to a loss of -2.02 percent which would occur under free trade in the high elasticity scenario.

IV. Food and Redistribution P. icies

Two points stand out from the previous discussions. First, it is not easy to find ways to raise the incomes of the poorest rural group by agricultural growth and trade measures. Second, changes in trade policy which would greatly benefit the rural sector as a whole, would tend to harm the poorest group. Indeed, in trade matters, this group tends to benefit from the same low food price policies which benefit the urban poor, although their benefits are somewhat smaller.

This leads to the following question: Can one find direct income distribution measures which would benefit the poorest groups without sharply reducing welfare levels of the rural sector as a whole? This question is explored in table 3.

The first group of scenarios explores various excise tax financed food subsidy measures. The excise tax is levied on nonagricultural consumption. As its direct incidence is closely related to the share of income spent on nonagricultural commodities it falls most heavily on the richest urban group. The proceeds of the excise tax are spent on importing additional food and/or on subsidizing food rations to various income groups. These rations are assumed to be inframarginal and can therefore be modeled straightforwardly as excise tax-financed income transfers. In scenario 1 the excise tax at the rate of 5.25 percent is simply used to finance additional wheat imports at the level of US$560 million. The additional wheat is simply released into the open market. The same tax revenue is spent in scenario 2 to provide food rations to all urban income groups. The urban rations are not imported but domestically procured. The food rations are the same for each group and provide an initial transfer to the urban poor of 10 percent of their income. The same ration provides an income transfer of 2.8 percent of their income to the urban rich.

The simple importation of additional wheat benefits primarily the urban poor whose income rises by 9 percent. The rural poor also benefit, but their gain is only about 2.2 percent, smaller than the gain of the urban rich who bear the brunt of the taxation. The rural poor do not gain more because their wage income drops as does their (small) share of farm profits. The real incidence of the excise tax therefore falls on the rural rich who see an erosion of their incomes by 7.4 percent.

Interestingly, an apparently equally urban-biased policy of providing food rations to all urban groups is made more favorable to the rural sector as a whole, if the supplies are domestically procured without adding to incomes. Consistent with Dantwala's (1967) hypothesis, the rural rich actually gain from such a policy because the price rises more than offset the direct incidence of the excise tax. (For discussions of Dantwala's hypothesis see Hayami et al., 1982; and Schiff, 1986). On the other hand, the urban groups gain less than from a simple increase in imports, and the richest urban group ends up losing absolutely as the incidence of higher food prices and higher nonfood prices exceeds the value of the food ration. The rural poor also lose but their loss is less than 2 percent. Consistent with our earlier findings, neither of these policies is able to affect their real incomes sharply.

How about targeting food rations directly to all poor groups? In scenarios 3 and 4 the poorest and the second quartile of the rural and urban areas receive a fixed and equal food ration which is scaled such that the poorest rural group receives an initial boost of 15 percent. The same ration translates into nominal income gains of 10 percent for the second rural quartile, 11 percent for the first urban quartile, and 9 percent for the second urban quartile. Thus the program provides nearly identical initial benefits to the urban poor as the previous program of urban ration shops only. This targeted program is much larger in magnitude than the urban fair-price shops, as half of the population now receives food aid. (The total urban population eligible in the previous scenarios is only 20 percent of India's population.) To provide for the expanded program by imports, 6 million tons of wheat and 2.1 million tons of rice would have to be imported. The excise tax rate would have to be at 14.75 percent of household consumption of nonagricultural goods, a very high rate.

When the extra food for the program is imported (scenario 3), the high income elasticity for food of the rural poor prevents the food prices from falling sharply on account of the high level of taxation of the rich. But again, the combination of reduced prices and excise taxes imply that the heaviest burden of the program falls on the rural rich. While wheat output declines substantially, aggregate agricultural output declines only by 0.36 percent because the agricultural sector expands its nonwheat production on account of changed relative commodity prices. The rural poor do lose some wage income but their gains on the price side more than offset this loss to give them a real income gain of 16 percent, which exceeds the nominal transfer by 1 percent.

By shifting from imports to domestic procurement the program costs can be shifted entirely to the urban population. Prices now rise so sharply that the gain for the urban poor is completely eroded, while the urban rich face a loss of 14.5 percent in their income. The rural rich, while taxed on their nonfood consumption, experience such a sharp rise in farm profits that their real income rises by nearly 5 percent. The rural poor who share to a very small extent in these profits, still gain about 10 percent, down from the 15 percent of the nominal transfer.

In order to achieve its poverty alleviation objectives and tax wealthy groups more evenly, the tax-cum food rations program would have to be combined with a food import policy aimed not at stabilizing food prices, but the price level of the economy. One such scenario is scenario 5 which combines scenarios 3 and 4 in a ratio of 3 to 1, i.e. about one-fourth of the food rations are domestically procured. Because the excise tax tends to increase prices, imports have to be sufficiently large to lead to a drop in agricultural prices and therefore a decline in farm profits. Under price stability, rich rural and urban groups get taxed about evenly. The initial gain of 15 percent of the rural poor is only minimally eroded, while the initial gain of the urban poor of 10 percent is increased by nearly 3 percent because of the decline in food prices.

While scenario 5 appears evenhanded and quite efficient in distributing income, a coalition of the urban and the rural rich is likely to attempt to defeat it because of the high excise tax rate of almost 14 percent on their nonfood consumption. Can one help the rural poorest more directly with a modest program aimed directly at them? Scenarios 6, 7 and 8 aim at raising the income of the rural poorest initially by 15 percent. In scenarios 6 and 8 this is achieved by providing a direct cash entitlement, while in scenario 7 it comes about by a land reform which transfers enough land from the richest group to the poorest group to raise their farm profits by the necessary amounts. Note that the transfer costs of these redistributive measures are ignored, as are the potential efficiency gains from a more equal farm size distribution. The immediate cost of this redistribution is carried by the rural rich in the case of the land reform as well as when a land tax is used to finance cash transfers. However, the land tax would also fall on smaller farmers. The excise tax has, of course, a much wider initial incidence, especially on the urban rich.

Redistribution to the poor adds to food demand on account of their high income elasticity compared to the richer groups. This demand is not accommodated by imports so that food prices rise. The benefits to the poor rural group is therefore somewhat eroded, but not by much. The food price rises compete food away from the urban groups and the urban poor lose, especially when they also have to pay directly via excise taxes. The major difference from changing the financing away from land taxes or land reform is that it shifts the costs entirely to the urban groups. The rural rich end up gaining on account of the food price rises. Of course it is possible to combine these distributional scenarios with import policies which achieve price stability. In all these cases the final incidence of the tax falls squarely on those who are taxed initially.

V. Conclusion

During the past two decades, Indian agricultural output has grown at an annual rate of 2.7 percent, which is extremely high by internationl standards. The technical changes associated with the Green Revolution have been an important part of this increased output, and there is no question that, had they not occurred, India would be far worse off today than it is. During the early Green Revolution period (1965-66), the real per capita income of the rural population of India rose by about 8 percent. However, these gains wererapidly eroded. The sobering point is that in 1980-81 real rural per capita income appears to have been only about 2 percent higher than in 1960-61.

The early productivity gains of the Green Revolution were retained by the agricultural sector because Indian policy makers used these gains to reduce imports of foods. Food prices therefore continued to rise slightly. But when near self-sufficiency was reached, all the extra output had to be absorbed domestically. Food grain prices declined, and terms of trade moved substantially against agriculture. The benefits of the productivity gains were thereby transferred to consumers, a classic case of the agricultural treadmill.

The early Green Revolution period was associated with a sharp rise in residual farm profits, while the real wage bill rose much more modestly. The real income gain of that period was distributed regressively; large farmers gained the most while the rural poor gained very little. However, the subsequent rapid drop of about 25 percent in residual farm profits reduced the per capita incomes of the rural rich to their 1960-61 levels. By 1980-81, both the absolute level of real rural per capita income and its distribution appear to have returned to about what they were in 1960-61.

Real rural wages (as measured by actual data) appear to have risen somewhat during the early Green Revolution but then dropped back so that by 1980-81 they were barely above the 1960-61 level. Agricultural employment (as measured by the model) rose substantially but at a rate slower than rural labor force growth. The rural poorest did not lose too much only because they shared somewhat in farm profit growth, in nonagricultural income growth, and in the consumer benefits from declining agricultural terms of trade.

The simulation suggests that it is extremely difficult to substantially raise agricultural labor incomes via agricultural development. When the expansion of agricultural output is confined from the domestic demand side the initial reduction in labor requirements, arising from enhanced efficiency in agriculture, cannot be offset via output expansion. But even when export markets are used to prevent price declines, the real wage bills hardly rise.[1/] What explains the remarkable stability of the agricultural wage billeven when there is elastic final demand?

The very small response in the wages is not caused by elastic labor supply. The total supply elasticity of rural labor, including the migration response, is less the 0.5. Demand for labor is also inelastic (-0.48) and thus cannot account for the limited wage response. Indeed, as shown elsewhere, when labor is withdrawn from rural areas because of reduced fertility, real rural wages increase sharply.

Instead the limited employment response arises from the inelastic supply of aggregate agricultural output. Even though individual crop supply elasticities are fairly large, when one crop expands it must compete with other crops for resources such as land, at least in the short-run.[2/]

1/ This conclusion could be altered if higher farm profits were spent on labor-intensive home goods of the rural sector, a linkage not included in the model. Note that these consumer demand linkages can only operate if prices do not decline, i.e. using them precludes benefiting the poor net food buyers as consumers.

2/ For a detailed discussion of aggregate supply issues see Binswanger et al. (1985).

Thus the aggregate supply elasticity is what matters. Enhanced efficiency will result in increased farm profits/land rents rather than in expanded employment if aggregate supply is inelastic. Constraints on international demand for India's major crop rice and on the aggregate supply elasticity therefore suggests that trade liberalization affecting only agriculture wouldnot benefit the rural poor.

Agricultural development measures on the other hand assist small farmers, the other poor rural group, almost irrespective of the trade policy context. This is, of course, consistent with a priori expectations. The only caveat is that the measures actually do reach the small farmers.

Our food policy scenarios suggest that it is possible to increase the incomes of both the rural and the urban poor while taxing the rich groups in both sectors by a combination of food rations which are targeted to all poor in rural and urban areas. But such a scheme can only be effective if the additional demand for food is accommodated by imports to stabilize the price level. The costs of such a program can be shifted entirely to the rural rich by importing the full amount of the rations provided and letting prices decline; or it can be shifted entirely to the urban sector by procuring the entire rations domestically. In the latter case, the urban poor gain nothing from the elaborate tax-cum and ration-shop scheme, while the gains of the rural poorest are substantially eroded. We also note that the taxation level required to implement a substantial redistributive scheme are very high. They can only be reduced by targeting the food rations or other cash transfers more narrowly to the poorest segments. As is well known, all these options are politically difficult. Sharper targeting erodes the political support for distributive measures, while less targeting leads to sharper opposition from the groups which have to be taxed explicitly.

Assisting the rural poor, who rely on labor income and are the net buyers of food via agricultural development or direct transfers, is clearly not easy. Evenly spread efficiency improvements do help them, but not nearlyas fast as one would hope. What then are the elements of a strategy for reducing the plight of these groups? A strategy must focus on reducing labor supply in the long run via demographic change. We have explored such scenarios elsewhere. In addition, nonagricultural labor demand must start to grow more rapidly. This calls for accelerating nonagricultural growth (either on urban or rural land), and for reducing distortions which reduce the efficiency of capital and increase the capital labor ratios in all sectors of the economy. While these are old themes, this paper emphasizes the crucial role of holding food prices down in economies where the poor are net buyers of food (see World Bank, 1986; or, de Janvry and Sadoulet). Agricultural development which increases self-sufficiency but does not produce lower food prices cannot help these groups much. While the rural poorest are not as vulnerable to food price changes as poor urban groups, their income is not nearly as buffered with respect to food prices as that of the small farmers.

Table 1

Simulated Indexes of Income Distribution and Their Sources, India 1960-61 to 1980-81
(1970-71 = 100)

Endogenous Variables	Agricultural Year 1960-71	1965-66	1970-71	1973-74	1975-76	1980-81
Real Per Capita Income (Actual)						
National	2.0	95.0	100	95.1	95.4	105.9
Rural, by Quartile						
First	1.0	99.0	100	95.9	97.4	107.0
Second	96.9	95.8	100	94.6	94.8	99.9
Third	93.8	93.5	100	93.8	93.3	96.3
Fourth (Richest)	88.5	88.6	100	92.4	90.7	88.8
Aggregate a/	92.9	92.4	100	93.6	92.9	94.9
Urban, by Quartile						
First (Poorest)	91.9	100.4	100	98.1	100.7	136.0
Second	90.9	102.8	100	99.3	102.6	141.9
Third	90.2	102.7	100	99.7	102.5	139.3
Fourth (Richest)	87.6	102.3	100	99.8	102.2	133.5
Aggregate a/	89.4	102.3	100	99.4	102.2	136.7
Agricultural Employment	98.2	100.1	100	112.3	118.8	118.5
Real Agricultural Wage Bill	91.2	95.3	100	101.4	104.9	105.4
Real Residual Farm Profits	64.2	67.9	100	86.0	85.1	76.4
Nonagricultural Income	71.9	93.6	100	111.3	121.8	182.7
Real Per Capita Disposable Income	92.4	94.5	100	96.7	97.8	113.6
Total Actual Agricultural Output	79.3	81.2	100	99.4	107.1	119.6
Actual Prices = Agricultural/ Nonagricultural Goods	89.8	97.2	100	97.7	91.6	76.3

a/ These estimates of per capita income are computed as in equation 1 = 17 of Appendix A (Quizon and Binswanger), in which the subscript k now refers to either the rural quartiles (R1 to R4) or the urban quartiles (U1 to U4) only.

Table 2

The Impact of Technical Changes, Development Measures and Free Trade in Rice on Real Incomes

Scenarios/Endogenous Variables	GNP Deflator	Farm Profits	Real Wage Bill	Real Per Capita Incomes: National Average	Rural Quartiles: Poorest	Rural Quartiles: Second	Rural Quartiles: Richest	Urban Quartiles: Poorest	Urban Quartiles: Richest	Rice a/ Exports	Domestic Rice Price	World Rice Price
Technical Change												
A. Closed Economy												
(1) 10% Rice Yield Increase	-5.98	-3.77	1.34	2.05	3.76	2.53	-0.69	6.01	2.87	0.0	-15.43	0.0
(2) 10% Coarse Cereal Yield Increase	-2.46	-.54	-1.23	.51	1.99	.92	-.06	1.64	.05	0.0	-0.90	0.0
(3) 10% Increase in Yield of All Crops	-18.13	-4.31	0.50	7.20	9.95	7.26	1.84	17.78	9.83	0.0	-12.98	0.0
B. Exporting to Maintain Price Stability												
(4) 10% Rice Yield Increase c/	0.0	8.03	1.48	2.47	2.09	2.80	3.70	0.84	0.02	2.69	-9.24	e/
(5) 10% Overall Yield Increase d/	0.0	31.35	1.49	8.55	5.49	8.58	14.78	2.25	0.66	2.28	0.39	e/
C. Other Development Measures												
(6) 10% Increase in Irrigated Area	-5.76	-4.79	1.14	1.71	2.92	1.71	-0.67	6.04	3.50	0.0	-6.93	0.0
(7) 20% Decline in Fertilizer Price	-1.13	5.58	-2.67	1.30	-0.35	0.75	2.54	0.60	0.40	0.0	-1.76	0.0
D. Free Trade in Rice												
(8) Low International Elasticities b/	1.48	2.88	0.04	0.10	-0.42	0.06	1.07	-1.27	-0.70	0.59	2.69	28.12
(9) High International Elasticities b/	7.11	13.85	0.20	0.46	-2.02	0.28	5.15	-6.08	-3.37	2.85	12.94	20.94
(10) Exchanging Rice fro Wheat (With High Elasticities)	-0.42	-0.83	-0.05	0.07	0.08	0.04	-0.05	0.48	0.16	0.50	-0.20	-3.68

a/ In metric tons.

b/ World price at 70% of India's price, converted at official exchange rates. Elasticity of world import = α_W = 0.8 for low elasticity and 0.87 for high elasticity scenarios. Elasticity of world exports = Σ_W = 0.14 for low elasticity and 0.55 for high elasticity scenarios.

c/ 54% of the initial yield gain is exported, i.e. 5.4% of base year rice production.

d/ 45.1% of the initial yield gain in all four crops or crop groups is exported, i.e. 4.51% of base year aggregate crop output.

e/ Level of world price decline depends on demand and supply elasticities in international markets. See note b/.

Source: Scenarios (1) - (7) from Quizon and Binswanger (1986).
Scenarios (8) - (9) from Quizon and Barbeiri (1985).

Table 3

The Impact of Food Subsidies and Direct Redistribution Measures on Real Incomes

Scenarios/Endogenous Variables	GNP Deflator	Farm Profits	Real Wage Bill	Real Per Capita Incomes						Wheat Output	Total Output
				National Average	Rural Quartiles			Urban Quartiles			
					Poorest	Second	Richest	Poorest	Richest		
Excise Tax in Financed Food Subsidies											
(1) Foreign Wheat Supply Released into Opened Market a/	-9.30	-19.54	-0.80	-1.28	2.20	-0.80	-7.42	9.09	2.58	-9.75	-0.32
(2) Domestic Procurement as Rations to All Urban Groups b/	6.62	8.68	-0.39	0.47	-1.82	-0.37	2.19	4.52	-2.40	0.79	0.19
(3) Foreign Supply as Rationed to to Rural and Urban Poor c/d/	-5.73	-19.85	-2.04	-0.03	16.07	8.28	-9.07	18.16	-4.13	-14.68	-0.36
(4) Domestic Procurement as Rationed to Rural and Urban Poor d/	17.11	20.59	-0.89	0.50	10.07	8.70	4.82	-2.79	-14.51	2.20	0.65
(5) Importing to Maintain Price Level	-0.02	-9.76	1.75	0.10	14.75	8.21	5.60	-12.92	-6.72	10.46	-0.11
Direct Distribution to Rural Poorest d/											
(6) Land Tax Financed	1.84	-1.69	0.33	0.16	13.94	-1.13	-1.12	-1.81	-0.94	0.43	0.06
(7) Via Land Redistribution	2.60	4.88	0.36	0.29	14.31	0.16	-2.16	-2.12	-1.12	0.68	0.09
(8) Excised Tax Financed	6.49	8.35	-0.31	0.40	13.14	-0.41	2.18	-5.32	-5.12	0.99	0.20

a/ This is 51% of Scenario (2), Table 1 in Binswanger and Quizon (1984).

b/ The rations are scaled so as to increase the income of the urban poorest by 10% initially.

c/ Imports approximately $1.7 billion.

d/ The transfers are scaled to increase the income of the rural poorest by 15% initially.

e/ Combines scenario 3 and 4 in a ratio of 3 to 1; i.e. about 25% of added demand is procured domestically.

Source: Scenarios (1) - (4) are from Binswanger and Quizon (1984). Scenario 5 is computed as discussed in note e/. Scenarios (6) - (8) are from Quizon and Binswanger (1986).

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