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Implications of the Green Revolution for Economic Economics Library

Growth: Mechanization, Scale and Labor Force Absorption*

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In a ten-minute discussion paper about all that one can do is throw out a few ideas in a hopefully stimulating way as a basis for joining the issues and engendering a true workshop or seminar atmosphere. Let me therefore focus the discussion in the following way. Let's assume that there will in fact be a Green Revolution, although Falcon's paper suggests that we are a long way from having a generalized process under way, and inquire, in the context of economic growth, what the implications are in terms of mechanization, scale, and labor force absorption. We will take the essence of the Green Revolution to be the development of new, improved varieties whose primary characteristic is that they have a greater response to the application of fertilizer.^{1/} The consequence of the new varieties and the increased use of fertilizer is a rather substantial increase in output in a relatively short period of time.

In the context of my assignment, let me make the following three propositions:

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^{1/} This is admittedly a narrow definition, but it does facilitate a narrowing of the discussion.

1. That for the most part this technical change will be neutral with respect to mechanization;
2. That in and of itself it will tend to be neutral with respect to scale;
3. That it will create major problems in terms of labor absorption and labor adjustment. In this aspect may well be the true revolution of the Green Revolution.

Now, let's consider each of these propositions in more detail.

Hayami and Ruttan, in an unpublished manuscript,^{2/} have presented a very helpful way of thinking about technical change in agriculture. They argue that we have had essentially two kinds or types of technical innovation. On the one hand there has been a biological innovation process associated with the development of improved varieties. The essence of this kind of technical change is that it has made possible or facilitated the substitution of fertilizer for land.

The new varieties are not inherently higher yielding in and of themselves. To the contrary, under "natural" conditions they yield no more than local or indigenous varieties. What is unique about the improved varieties is that they respond to the application of fertilizer. With increased applications of fertilizer, their yields go up rather significantly, while the local varieties either produce the same yield or actually experience a decline in yield. Hence, what the new varieties really do is facilitate the substitution of fertilizer for land which results in an increase in the productivity of land, and in turn economizes the land resource.

The second kind or type of technical change involves the process of mechanical innovation. Interestingly enough, this class of technical

^{2/} Yujiro Hayami and Vernon W. Ruttan, Resources, Technology and Agricultural Development: An International Perspective, University of Minnesota, St. Paul, June 1970 (mimeographed).

changes has certain characteristics that make it similar in many respects to the new varieties. The essence of the mechanical technology is that it facilitates the substitution of land for labor, and results in an economizing in the use of labor by making it more productive.

The two kinds of technical change have been directed towards two kinds of resource rigidities or resource supply inelasticities. One has been directed towards the inelasticity of supply response for land, and the other towards the inelasticity of supply response for labor. Which kind of technical change a country experiences is determined by its relative factor endowment, or by the relative supply price of the inputs.

What is important from our standpoint is that the two kinds of technical change can and do proceed somewhat independently of each other. The best examples of this phenomenon are the respective experiences of Japan and the U.S. Japan has been a land-scarce but labor-abundant economy. As a result the technical change for a long period of time was of a biological nature, with new varieties and increased use of fertilizer leading to higher yields. However, the increase in land productivity was obtained with very little increase in labor productivity.

In the U.S., the experience was just the reverse. We were labor-scarce, but land-abundant. The consequence was that for a long period of time our technical change was primarily mechanized in nature. Moreover, the productivity of labor increased while the productivity of land stayed about constant.

That the nature of the technical change in the two countries has changed in recent history is only additional support for the hypothesis.

As industrialization proceeded in Japan and labor became scarce, a mechanization process started and labor productivity started to rise. In the U.S., we became interested in biological research only after the frontier closed and land became relatively inelastic in supply. As the biological research has paid off, yields and hence land productivity have increased.

It is on the basis of these considerations that we postulated earlier that the seed-fertilizer revolution could be expected to be neutral with respect to mechanization. However, there is a sense in which the improved varieties may facilitate mechanization. Suppose firms are experiencing internal or external capital rationing. The improved varieties which have a higher yield potential may reduce both the internal and external capital rationing because of the potentially larger income stream which can be generated, at least in the short run. This may be an incentive to increased mechanization, although in the final analysis whether it does or not will depend importantly on relative factor price ratios.

The scale neutrality of the green revolution can be argued very simply. Both the improved varieties and the fertilizer are perfectly divisible. Hence, we would not expect them in and of themselves to have a scale effect. To the contrary, an advantage of them is that they enable the production of a larger output without enlarging the land area.

However, if the new seeds and fertilizer reduce capital rationing, and price relatives are such as to encourage mechanization, then there may well be some second order scale effects. The lumpiness or indivisibility of tractors and machinery may produce some internal economies. This will be a second order effect, however, and not a direct effect.

There is another way in which a scale effect may be generated, however. If tenure arrangements are sufficiently flexible, the rather large output effects may lead to changes in share arrangements. Such changes in themselves can lead to recombination of parcels into large units, particularly in the hands of the more competent and well-financed. Mellor^{3/} cites an example of this occurring in India, where landlords evict tenants and resume cultivation in order to reap the full benefits of the improved varieties. Clearly this can lead to substantial internal growth within the firm.

✓ Finally, let me turn to the problem of labor absorption. The emphasis is on problem -- because that's what I think it is going to be. Many analysts are now arguing that an advantage of the green revolution is that it is going to alleviate the labor absorption problem present in most low income countries by creating employment opportunities in the agricultural sector. A good example of this position is presented in a recent paper by Johnston and Corvine^{4/} in the American Economic Review.

✓ I want to argue to the contrary. In my judgment a major consequence of the green revolution is going to be to create a serious problem of labor absorption and labor adjustment in most underdeveloped countries. Moreover, the social and political consequences of this phenomenon will be so great that most countries will have a difficult time controlling them without resorting to force and repression.

^{3/} Mellor, John W., "Report on Technological Advance in Indian Agriculture as It Relates to the Distribution of Income", Cornell University, Ithaca, N.Y., December 12, 1969 (mimeographed).

^{4/} Johnston, Bruce F., and Corvine, John, "The Seed-Fertilizer Revolution and Labor Force Absorption", American Economic Review, Vol. 59, No. 4 - Part I (September, 1969), pp. 569 - 582.

✓ The labor adjustment problem will have two aspects. One will be the need to adjust labor out of agriculture in the aggregate. The other will be the regional problems that will arise from the creation of disadvantaged Appalachias. Let's call these the sectoral problem and the regional problem, respectively, and discuss them in more detail.

Our own U.S. experience provides ample insights into the nature of the sectoral problem. Our secular farm income problem has been in large part the results of a stream of technology being played into the agricultural sector, and the agricultural labor force having to bear most of the burden (costs) of the adjustment. This was perhaps best exemplified during the decade of the 1950's, when relative incomes in agriculture lagged badly behind those in the nonfarm sector at a time when output was expanding rapidly.

✓ What should give us cause for concern is that in the U.S. case the agricultural labor force was already declining absolutely, the agricultural labor force was already declining absolutely, the agricultural labor force was a relatively small fraction of the total labor force, we had a relatively large nonfarm sector in which to absorb the migrants, and although deficient in many respects, we at least had some form of educational system in the rural areas. Compare this to most LDC's, where the agricultural labor force is 50 percent or more of the total labor force, the agricultural labor force, and total population are increasing absolutely, the nonfarm sector is small and though in many cases expanding, is not absorbing very much labor, and where educational opportunities in rural areas are sadly deficient or practically nonexistent.

✓ The reasons for the labor force having to bear most of the adjustment associated with technical change are rather well known. The income elasticity of demand for food products in the aggregate is low relative to that for other products (even though it is higher absolutely in the LDC's than in the advanced countries), the price elasticity of demand tends to be smaller than -1, which means that gross income declines as output increases, and land tends to have few nonfarm alternatives. Hence, the presumption is that the labor force has to bear the consequence of the adjustments. Unfortunately, and more seriously, the disadvantaged within the agricultural sector are the ones who generally bear the adjustment.

The dynamics by which this process works itself out are rather interesting. The direct effect of a technical change in agriculture, such as the seed-fertilizer revolution, is to increase the demand for labor. The new technology raises the physical productivity of the labor which, if product market effects are ignored, will increase the demand.

However, the problem is that the effects in the product market cannot be ignored. The increase in output which results from the adoption of the new technology drives the product price down, other things being equal. If the price elasticity of demand for the product is inelastic, the price or market effect will outweigh the physical product effect, and the demand for labor will shift to the left. Empirical support for this proposition has been obtained by Wallace and Hoover in their econometric study of the U.S. labor market.^{5/}

^{5/} Wallace, T. D., and Hoover, D. M., "Income Effects of Innovation: The Case of Labor in Agriculture", Journal of Farm Economics, Vol. 48, No. 2 (May, 1966), pp. 325-336.

✓ The skeptic, of course, will argue that in most poor countries per capita incomes are so low that both the income elasticity of demand and the price elasticity will be relatively high. Moreover, they will argue, the labor can be shifted from producing those products with low price and income elasticities to those with relatively higher elasticities such as meats and fruits and vegetables.

✓ Two points seem in order. First, the benefits of the higher price and income elasticities cannot be realized unless the increase in agricultural output and the surplus which it implies are transmitted into real income gains for the low income classes. That is not an easy matter. Second, the shift into products with higher price and income elasticities already implies an adjustment, and for the most part these shifts require the acquisition of new skills and the accumulation of capital in other forms. The frequently recommended shift into livestock is a good example of these needs.

✓ The regional consequences of the new technology are likely to be as serious as the sectoral consequences and in fact are an important dimension of this same problem. Regions in which the new varieties are especially adapted will experience a net gain. But the regions where they are not adapted will suffer a comparative disadvantage. The lower prices for the products which results from the new technology will impose serious income losses on those in the disadvantaged regions. The Appalachias will be legion, and there is a presumption that these will be in regions that are already comparatively disadvantaged.

✓ What makes both these problems especially serious in most low income countries is that they already have serious labor absorption

problems. Many of these problems arise from misguided economic policies which have distorted factor prices so that they do not reflect true resource scarcities. The price of labor is forced above its equilibrium level by minimum wages and other social legislation. The price of capital is set below its equilibrium level on the false premise that this is the most efficient way to stimulate industrialization. The consequence of such policies is a capital intensive industrial sector which absorbs very little labor, despite the presence of rather rapid increases in output.

A Concluding Comment

Recognition of the income and employment problems which will be created by the Green Revolution should not be taken as a cause for despair, nor should it cause us to back off in the efforts to generate and distribute the new technology. The new varieties are clearly a tremendous source of growth.

However, a central issue which arises once this process of growth is underway is how the rapidly growing economic pie will be distributed. Major adjustments in resource allocation will be required as a result of the new technology. It seems inevitable that a major fraction of the costs of that adjustment will be borne by members of the agricultural labor force. Analysis and policy measures should be directed to the solution of these problems early in the process in order that the social fabric not be rent by unrest and violence.

The expectation of serious labor adjustment and labor absorption problems may be attenuated in a number of ways. First, it is possible that biological technology can lead to an increase in labor productivity,

particularly if it increases the labor inputs required per worker. This would occur, for example, if the biological technology was such as to lead to multiple cropping. Apparently this has happened in Taiwan, with the result that the new biological knowledge has led to an increase in both land and labor productivity.

However, such developments would also seem to lead to sizeable product market effects in the aggregate over the longer term, with the result that the demand for labor would ultimately shift back to the left. The best that can be expected from such changes, therefore, is the purchase of a little more time to facilitate the necessary adjustments.

A second ameliorating influence will be the shift into products with higher demand elasticities. However, these adjustments will not be easy, and cannot be expected to play a major role in either the short or long run, especially if the technical change becomes generalized.

A third factor which may alleviate the problem is the possibility of expanded trade. This is a route that one country can follow if it concentrates on out-competing others. Clearly it is not a game which all can win. Two aspects of the present trade situation should dampen the enthusiasm for trade possibilities. In the first place, many countries are using the Green Revolution in an effort to become self-sufficient and to economize foreign exchange. Secondly, it does not seem likely that the advanced countries are going to open their doors to agricultural trade, since most of them are already protecting their agricultural sector at a rather sizeable cost.

Since none of these ameliorating influences appear to have a great deal of potential, it seems clear that the agricultural labor force is

going to experience major adjustment and income problems in those countries where the green revolution takes place. Policy measures should therefore be directed to facilitating this adjustment process, and to seeing to it that the surplus created by the new varieties is channeled into employment-generating activities. On the one hand this will require the maintenance of investment incentives so that private enterprise will be motivated to invest the surplus in activities with both forward and backward linkages. Similarly, it will be important to tax off some fraction of the surplus for investment in the social infrastructure, such as roads and education, which will not only provide some direct employment effects, but also open up other employment opportunities.