# DISEQUILIBRIA IN DEVELOPING ECONOMIES: Old Problems and New Priorities*

by

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One of the more important products of the annual conferences of this association has been the contribution to the growing body of knowledge about the development process. 1/ In the last two years, a topic commanding major attention within the community of development economists has been the impact of the green revolution technologies on agricultural and economic development. The diffusion of these practices has been shown to offer potential solutions to many existing problems. But some new problems have been reported also. Perhaps more important is the way many previously existing problems have surfaced with an increased order of magnitude.

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Given the apparent world food crisis in the mid-1960's major attention was focused on devising strategies to increase agricultural production in food deficit countires. Because of the magnitude of the problem, scarce resources, and limited knowledge this focus can be rationalized. Nevertheless, many of the problems emphasized by the adoption of the new production practices are the consequence of an almost singular focus on increasing food production. For example, production and income distribution responses to changes in farm price policies and the diffusion of new production practices seem to have exaggerated already existing income distribution disparities. An examination of some of the side effects which have emerged in coincidence with the diffusion of the new production practices in developing countries may shed additional insights into the nature of the development process. Such an attempt is the purpose of this paper. While most illustrations relate to India and South Asia, the paper also offers insights into problems in other developing regions as well.

With the view that many problems induced by the diffusion of the seed-fertilizer technologies are essentially old problems which command increased attention, this paper focuses on two aspects of the development process. The first concerns the distribution of the benefits of economic development not only among regions within a country but also among all portions of the population within regions. Widening income disparities within and among regions, it is argued, are partially a consequence of (1) a high level of investment in wheat and rice production technologies relative to other crops and (2) inter and intraregional disparities in the distribution of resources which are essential to the application of the new farm practices. The second section contains a

proposal for reallocating public sector development funds as a partial means of reducing income disparities among and within regions. A brief digression on the history of green revolutions helps to place our current problems in a more complete context.

## Lessons From Preceding Green Revolutions

By reading a bit of history, one learns that the phenomena currently called the Green Revolution is not unique to the 1960's. Among other countries, Japan, Taiwan, Korea, and Mexico previously passed through periods in which production of one or more crops increased markedly in only a few years (21). 2/ In these countries, periods of dramatic yield increases were the result of an accumulation of a critical mass of agronomic research, education and technical assistance, and, farm capital (24,27). These features also characterize the recent experiences in West Pakistan, India, the Philippines, and other countries.

While Green Revolutions have historical precedent the recent increases in farm productivity in several developing countries emphasize the catalyzing effect of the public sector in creating viable, modern economic production and distribution systems. 3/ That economic activity is imbedded in and coordinated through a diverse network of social institutions is not a new idea. 4/ Nevertheless, rapid increases in farm production have been most pronounced in those countries (regions) where modern economic institutions have been able to induce cultivators to participate in an economic system which passes beyond their immediate physical environment.

Public sector investments in agriculture and the creation of modern economic structures are designed to compress the development period with

respect to time. If they are to be effective there is an increased premium placed on the time sequencing of development activities.

The development process, consists not of surmounting a single or even a small group of inhibiting factors. Rather, inhibitors to development constitute a series of layered constraints. 5/ These constraints can be addressed one at a time as their impeding influence becomes obvious. But this haphazard strategy does not economize on time (17). By examining previous green revolutions, the cause of them, and their ensuing consequences, much can be learned which will enable policy makers to anticipate subsequent constraints and take corrective action in advance.

## Income Distribution

The introduction of the new genetic technologies has focused increasing attention on the skewed distribution of incomes in developing countires. This problem, which in agriculture has stemmed largely from a skewed distribution of land resources, is not a new item of concern. The problems of the small farmer and the landless laborer have been the subject of intensive analysis. 6/ Nevertheless, income distribution problems command increasing attention because most of the benefits from the new farm production technologies appear to be accruing to those persons and regions which control certain scarce resources -- primarily land with an assured water supply (14,44). If the benefits of increased agricultural production are not widely distributed, the economic problems and political consequences may be large. 7/

The income distribution problems highlighted by the introduction of modern farm practices are of two basic types. The first stems from the location specificity of the practices themselves. Much evidence has been compiled which shows that these practices have not been equally applicable in all regions of developing countries. Consequently, in countries where

the genetic technologies are applicable, rapid development is occurring in some areas while in others productivity and income levels have not noticeably changed.

The second basic type of income distribution problem focuses on the distribution of income among economic groups within regions. One aspect of this problem concerns whether the new technologies are being adopted by a relatively few operators of large farms to the exclusion of the more numerous, but less prosperous, operators of small farms. 8/ A related question is whether the increase in the demand for farm energy, which results from adoption of the new technologies, will substantially increase viable employment opportunities for landless laborers.

Regional Differences in Production Possibilities

Recent rapid increases in agricultural productivity have been regionally and cropwise specific. Regions in which the preconditions for rapid agricultural development were already present have been most significantly affected by the new production technologies. In India, for example, wheat production doubled between 1965 and 1970 (39,p.56). But to infer that this was a country-wide phenomenon is misleading since the application of these technologies has been concentrated in northwest India. Prior to the introduction of dwarf wheat varieties, Punjab, the state where these varieties have been most widely adopted, was already the most rapidly developing region in India (22). Among other factors, substantial public and private investment in irrigation development enabled farmers to effectively manage their water resources (14,p.699). 9/ The story is similar with respect to wheat in northern Mexico and West Pakistan (40). Likewise, high-yield rice has been adopted in select regions in the

Philippines and West Pakistan (12).

Further, the most significant changes in production possibilities have occurred in the two major foodgrains -- wheat and rice (40,p. ). Consequently, farm production has changed more markedly in regions where these crops are widely grown relative to areas where they are not.

The American experience with hybrid corn offers an interesting parallel to the diffusion of high-yield varieties and related practices in developing countries today. Griliches (19,p.280) concluded that hybird corn was an innovation which was more profitable in the "good" areas than in the "poor" areas. Hybrid corn not only was introduced into "good" areas earlier than "poor" areas but also the rate and degree of adoption was greater in the "good" as compared in with the "poor" areas. For example, hybrid corn was introduced in Iowa in 1936 and in four years was planted on more than 90 percent of the land in corn. A variety well suited to Alabama was not available until 1948 and after 12 years less than 90 percent of the land in corn was planted with hybrid varieties. These interregional differences in the diffusion of hybrid corn are partially related to differences in the relative importance of corn in the agricultural economies in these respective states (18,p.522). Corn, a major component in Iowa agriculture, is of relatively small importance in Alabama. Even when widely accepted by Alabama farmers, hybrid corn had a small effect on agricultural incomes, relative to Iowa, in the state. This is partially because hybrid corn did not markedly alter Alabama's comparative advantage in cotton relative to corn. Similarly, the new wheat and rice production technologies are having only a minor aggregate effect on farm production in regions where these crops were not

previously grown.

Even between the wheat and rice growing areas, there are substantial differences in the effect of the genetic technologies on crop output. Relative to wheat, the initial acceptance of high-yield rice by Indian farmers, for example, has been much slower (40,p. ). Part of this has been due to (1) the uncertainty of results from agronomic and genetic research and (2) incomplete knowledge about the adaptability of the new varieties to particular areas. Early strains of high-yield rice had inferior grain quality, were more succeptible to disease, and required more precise water management than is possible on most farms producing rice. Adaptive research is expected to result in (within three to five years) high-yield rice varieties which, with some reduction in yield potential, surmount the limitations of earlier high-yield rice varieties (13). These are problems which are surmountable. Nevertheless, the forgoing suggests that, when economic growth is stimulated by the introduction of production technologies, the distribution of the benefits derived therefrom may not be distributed evenly throughout the economy.

More serious are the production limitations in regions deficient with respect to land and water resources, especially the latter. The state of Maharashtra, India, is a state in which water availability is particularly scarce. 10/ With only seven percent of the land area irrigated, most farmers in Maharashtra can grow one rain-fed crop per year. Further, informed observers anticipate that by 1984, only 15 percent of the land will be irrigated (5).

The most marked increases in farm output have occurred in crops and regions where adequate moisture is available to farmers when needed--either through irrigation or in some cases where natural rainfall is

adequate. While high-yield varieties of dryland crops, (eg. sorghums and millets), have been adopted by some farmers, the total impact of these varieties on farm production has been small. Further, given the high cost of marginal increases in land area irrigated, few expect to see significant increases in production possibilities in regions seriously deficient with respect to agricultural resources (5,p.71).

Consequences of Regional Differences in Agricultural Development: Unless the level of farm production in resource deficient areas increases more rapidly, income and employment disparities between these and developing areas will increase. The cost of increasing production and employment opportunities in these regions may be high. Nevertheless, continued unemployment, under-employment, and low incomes in resource deficient areas may, as a consequence, have external effects in developing areas.

Low employment and income opportunities encourage migration to areas where employment opportunities are believed to be better. 11/ Many of these migrants are attracted to large urban centers. Rapid increases in the urban population characteristically are accompanied by large increases in the demand for public services. Given the demands for public revenues which induce corporate growth, these are public expenditures which developing countries can ill afford. Further, migrations such as these will, by increasing the supply of labor (unskilled labor in particular), magnify already existing employment problems in developing areas and large urban centers. 12/

The possible exaggeration of regional income disparities raises an important question with respect to development policy. Is it better for a country to permit regional income redistribution to occur through

regional redistribution of (1) the population, (2) production resources, or (3) some combination of the two. 13/ The choice to be made among the three is not obvious, and will vary among and within countries. Nevertheless, it appears that the first option should be chosen only after the second has been determined to be economically infeasible. The concluding section of this paper contains a proposal which may provide a starting point for stimulating more rapid development in regions where the new production technologies have not been widely adoptable.

## Income Distribution Among Economic Groups

Within regions the income distribution problem centers around the control of scarce resources. The income distribution problem can be considered in two dimensions: (1) differences in the level of adoption of green revolution technologies on small relative to large farms and (2) the effect of the adoption of green revolution technologies on the employment of hired labor. The nature and magnitude of these problems varies among countries. Some observations drawn from the Indian experience offer useful insights. 14/

Small and Large Farmers: Some analysts (9,27,44) have suggested that small farmers are not sharing in the adoption of green revolution technology. Large farmers tend to have control over more resources and, hence, have a volume of production far in excess of their numbers relative to the total farm population. For this reason large farmers may be obtaining a proportionately greater share of the income benefits of the new technologies than small farmers. This tendancy, while perhaps exaggerated in developing countries, is also an important aspect of the farm income problem in the United States and other developed countries.

Of equal or perhaps greater importance is the possibility that small farmers may be excluded entirely from participating in the green revolution. However, data from areas in India where high-yield wheat and rice have had a large impact suggest small farmers are adopting these technologies. 15/

Noteworthy is the fact that the new genetic technologies involve the application of biological capital -- irrigation, seed, fertilizer, and pesticides. 16/ Hence, other things being equal, in many areas these practices are divisible and, hence, are adoptable regardless of farm size.

In 1967/68 almost 80 percent of 150 farmers sampled in Ferozepur, Punjab had begun growing high-yield wheat varieties even though few farmers had completely discontinued producing local wheat varieties. Given that high-yield wheat was not commercially available prior to 1965/66, this level of adoption is significant. 17/ Farmers in this sample were stratified into five groups by size of farm. Within each stratum the proportion of farmers using high-yield wheat in ascending order of farm size, was 70, 87, 60, 80, and 77 percent, respectively (39,p.58).

An identical size sample of farmers in Thanjavur District, India (a major rice producing district) suggested that 82 percent of the farms in this district had adopted high-yield rice varieties.

That small farmers in these districts are participating in the green revolution is due, in large measure, to deliberate efforts by the government to expand the production opportunities available to small farm operators. Ferozepur is a district of relatively large farms by Indian standards; even the smallest farms generally exceed one hectare. Although farms in Thanjavur are much smaller, farmers in this district have benefited from the fact that Thanjavur has been included in the Intensive Agricultural Development Programme (IADP) (25). Under this program farmers

willing to participate have been assisted in adopting modern farming practices and the associated purchased inputs. This program, however, has been fully implemented in relatively few districts.

The preceding analysis does not conclusively demonstrate that small farmers in areas not covered by IADP or similar programs are sharing in the Green Revolution. Nevertheless, these data do suggest that, given the biological nature of the seed-fertilizer technologies, small farmers can adopt modern farm practices along with larger farmers. But such a distribution of benefits does not occur spontaneously. To involve small farmers requires that (1) specific attention be focused by public institutions on the needs and production limitations facing small farmers and (2) efforts be made to surmount these obstacles.

Employment: Given high rates of population growth relative to the rate of economic development, most developing countries face a serious and growing unemployment problem. Farmer adoption of modern farm practices also induces a marked increase in the demand for farm energy (4). Consequently, widespread adoption of green revolution technologies can result in a substantial increase in the number of viable employment opportunities in developing agricultural economies (4,39).

The influence of high-yield varieties and related technologies on employment of labor and other resources on a cross section of Indian farms is illustrated in Table 1. Farms growing high-yield varieties of wheat and rice spend considerably more per hectare for labor and other inputs relative to farms growing traditional varieties. 18/ With increased applications of fertilizer and water, better field preparations, greater crop volumes to harvest, etc., more labor is required. Perhaps more important, employment opportunities are expanded due to possibilities for

Table 1. Cash input: costs of high-yield varieties as opposed to local varieties of rice and wheat, for 1967-68 (32,33).

| Variety | Input (Rupees per hectare) | | | | | |
|---|---|---|---|---|---|---|
| | Seeds | Fertilizer | Labor | Irrigation | Other | Total |
| | | | Wheat | | | |
| High-yield | 69.9 | 232.8 | 191.5 | 58.6 | 52.6 | 605.4 |
| Local | 4.7 | 22.0 | 41.0 | 12.4 | 4.9 | 85.0 |
| | | | Rice | | | |
| High-yield | 30.1 | 332.8 | 367.4 | 27.7 | 40.5 | 798.6 |
| Local | 8.2 | 104.3 | 190.5 | 13.8 | 16.8 | 333.6 |

double cropping, made more feasible because the new varieties have a shorter growing period than traditional varieties.

Many Indian farmers are engaged in production activities on their own farms for considerably less than the total number of days for which their labor is potentially available. 19/ The existence of large amounts of unused labor within the farm family implies that family labor may be able to provide the bulk of the increase in labor required. If this is true, a large portion of the income benefits from the Green Revolution may be internalized within the farm family with little increase in farm wage employment.

However, much of the increase in farm employment resulting from adoption of green revolution technologies appears to actually accrue to hired labor. Data from a cross section of farms in each of two developing districts in India, one wheat producing (Ferozepur) and one rice producing district (Thanjavur), were used to examine the derived demand for family, permanent and casual labor (39). The amount of each respective kind of

labor was postulated as being functionally determined by: (1) a set of production function variables, (2) the price of the respective kinds of farm labor, and (3) the quantity of other kinds of labor employed. 20/ The amount of family labor employed per farm did not vary freely with variations in the quantity of other inputs employed per farm. Hired labor, however, (casual labor in particular) was significantly related to the amount of other farm inputs employed per farm. Variations in expenditures for seed and fertilizer had the most marked influence on employment of hired labor.

The increase in demand for farm labor, particularly harvest labor, due to changes in wheat technology is illustrated by an increase in the price of farm labor in Punjab, the state in India in which high yielding varieties have been most widely adopted. The going rate increased from Rs. 3.5 in 1965/66 to almost Rs. 7.0 per day in 1968/69 (39,p. ).

The increase in the cost of farm labor introduces a complicating factor with respect to the unemployment problem. Increasing labor wage rates implies an increase in the cost of labor relative to capital and induces farmers to substitute labor saving implements for labor. But even without an increase in the price of labor, farmers in Ferozepur, because of the marked increase in demand for farm energy have strong incentives to adopt implements such as tractors, reapers, and threshers. These machines are especially helpful in dealing with the critical labor bottlenecks encountered where multiple cropping is practiced. As a consequence, since 1960/61 the tractor population in Punjab has increased from 5,000 to over 20,000 (39, p. ).

The introduction of large tractors on farms in certain areas of a

country generally described as a surplus labor economy has fostered wide controversy. Some analysts contend that under certain circumstances tractor mechanization can considerably enhance farm productivity with no decrease in employment generation (15,p.225). Others believe that the social costs of tractor mechanization, measured in terms of decreased employment opportunities, will be too great (23). The issue boils down to whether the substitution of machine power for labor in certain operations if offset by an increase in employment opportunities due to the increased intensity of farm production.

An analysis of the 150 farms in Ferozepur, Punjab demonstrates that large farms using tractors employ more hired labor per hectare than large farms not using tractors (39,pp. ). This tendency is related to the fact that farms with tractors tend to be cropped more intensively within and among seasons relative to large farms without tractors. Tractors, therefore, appear to enhance employment opportunities by permitting a greater level of cropping intensity. 21/ Whether this relationship is indicative of similar relationships in other areas or other countries is a question demanding further research. Nevertheless, these results suggest the following hypothesis: large farms without access to tractor services which must rely on human and bullock draft power, may not intensify farm production to a level similar to that achieved on tractorized farms. 22/

Reapers and threshers are being rapidly introduced on farms in northwest India. Unlike tractors, which directly substitute for bullock labor, these implements substitute directly for harvest labor. While the net effect of the introduction of these implements on hired labor is as yet unknown, their use may have a large negative influence in the amount of harvest

labor employed (39, p. ). This suggests that a balanced public policy with respect to agricultural mechanization and employment may be required. The use of some implements may, under certain circumstances, may simultaneously enhance farm production opportunities and farm employment. Others may be incompatible with a labor intensive agriculture.

## Implications Regarding the Distribution of Income

The related problems of regional income disparities and intraregional problems of distribution existed before the new farm practices and related inputs were introduced into developing economies. The exaggeration of these income disparities, however, is not an inconsequential side effect of agricultural development. Further, that these problems seem to have been exaggerated by the introduction of modern farm production techniques demonstrates that new technologies are no panacea for development. Few of those engaged in the generation and distribution of green revolution technologies seem to have anticipated the magnitude of the destabilizing effect associated with the insertion of these practices into countries where modern allocation mechanisms are developing simultaneously. 23/

Structural changes in the institutions which direct production and resource allocation decisions in the private sector bear a large responsibility in resolving these problems. These adjustments are primarily the responsibility of the countries involved.

Much of the progress in increasing food production (where progress has occurred) in the developing countries has been due to large investments of capital and knowledge by the developing countries themselves and the international development community. As members of the latter we would do well to realize that the distribution of the modern farm

practices may have an effect on the entire economy far beyond a simple increase in farm production. Many of these effects are highly desirable, while others are not.

While food production in most developing countries is not yet increasing as rapidly as is necessary, it appears that time has carried us beyond the food crisis situation of the mid-1960's? A broader guaged policy which recognizes the redistributive effects of production technologies is needed. A reallocation of public investments in the generation and diffusion of production technologies may do much to increase the production opportunities for farmers and regions where the new production technologies are not yet applicable.

## Public Sector Resource Allocation

Development consists of surmounting a series of layered constraints (6). These constraints consist not only of a lack of production knowledge but also of impediments related to credit, land tenure, and legal systems, to mention only a few. Surmounting these obstacles can be facilitated by action in the public sector. Improving the services of a single given public sector institution, however, may do little more toward development than give way to another constraint posed by some other inadequately developed institution (2).

In competing for development funds, public sector resource allocation decisions must be framed on the basis of resource demands (1) among alternative development institutions and (2) alternative areas of focus within institutions themselves. Further, when viewed in this framework, research institutions should have to compete with other rural institutions for scarce development funds.

A key question then becomes the one of establishing priorities for public institutional improvement. Although there is no single set of priorities that will serve all developing countries, there is a conceptual framework which will enable analysts to deal with this problem in the agricultural sector.

The conceptual context appropriated at this point requires viewing institutions as producers of services which are, in turn, inputs into the agricultural development process. Viewing institutional services as inputs enables one to conceptually identify marginal value productivities with each. Given these estimates of MVP's, resources can be allocated among institutional alternatives until their MVP's are equated. 24/ Clearly, the calculus of this resource allocation process is a complex one requiring on-site information.

As an initial point of departure for this type of analysis, questions can be raised about the contributions of institutions to development in a pareto optimum sense. However, they should not be limited to small marginal reallocations only. Recognition must be made of the fact that some institutions may require massive and sustained injections of resources, i.e., there may be a lumpy input problem. For example, until massive amounts of resources are committed to research on farm production in arid areas so that a breakthrough is achieved, the production opportunities in these areas may remain almost unchanged.

The question of resource allocation among and within competing development institutions can be illustrated in the context of the three regions in India examined earlier in this paper. 25/ In Punjab (see Ferozepur illustrations) high-yield wheat has been widely adopted and the impact on

incomes in that state has been significant. In much of the rice growing area high-yield rice is expected, within only a few years, to have a marked effect on production and hence on incomes and employment opportunities. In regions where the new farm technologies are not applicable, especially arid ones without promising irrigation potentials, there is a lack of knowledge with respect to the means by which agricultural production can be increased under existing resource restrictions. Framed in this manner we can perhaps come closer to a decision mechanism for allocating resources among and within development institutions.

In those areas where green revolution technologies have been widely adopted (eg. Punjab), the limiting developmental factors seem to lie in areas other than a shortage of production knowledge. Consequently, in these areas emphasis perhaps should be shifted to providing other institutional services (eg. electric power). Further, a net shift in aggregate public sector investments from these to other areas may be appropriate.

In the rice producing areas, further genetic research is required to fulfill the promise of high-yield rice varieties suitable for planting under conditions where precise water management is not possible. When this occurs, however, developers should be prepared to shift resources to the creation of other institutional services, the lack of which are constraining development. An examination of the consequences of wide-spread adoption of high-yield rice in those areas where these varieties have already had some impact will help anticipate these needs.

In some areas (eg. Maharashtra) the lack of a well distributed supply of water for intensive crop production is a key factor limiting farm production. Further, many experts believe that massive public sector resource

development schemes, particularly irrigation, are economically infeasible. Yet, without substantial efforts to develop areas like these, developing countries will have to cope with the existence of large regional pockets of poverty and the attendent problems.

The potential development contribution of research institutions in these resource deficient regions may be particularly great. That is, the priority need in these areas seems to be the generation of production technologies which, while substantially lower than in the more well endowed regions, markedly surpasses those now prevailing in these areas. The need is for production knowledge which economizes on the use of the scarcest resource (in this case water).

In allocating research resources, as well as other public sector resources, administrators tend to focus on those areas where the immediate net payoff is largest. On the surface, this is good economics. This allocation decision criteria may be inappropriate, however. Research funds as well as all other public resources should be allocated to maximize the intertemporal public welfare (30). Consequently, in allocating public development resources the social consequence of regional non-development must be considered, in addition to the direct cost of and probability of success in generating new production technologies.

This strategy for encouraging the development of areas where the new farm practices do not apply may, after full examination of the private and social costs and benefits, prove to be infeasible. Investment in research, however, is an investment in idea generation. It would be most unfortuante to give up on the development of lagging areas because

meaningful ideas as well as people were left behind.

## Summary

The introduction of green revolution technologies has highlighted and exaggerated already existing disequilibria conditions in developing countries. Primary among these problems is the dual-faceted problem of income distribution. While the distribution of benefits among economic groups within regions has been less than egalitarian, the exaggeration of regional income disparities may be the more serious of the two.

The income distribution problem highlighted by the dissemination of high-yield varieties emphasizes the fact that development consists of addressing a series of layered constraints. Research institutions are only one among many institutions providing development services, the lack of which could be constraining the agricultural sector. The need for the services of these institutions varies among countries as well as within regions in those countries as a function of the stage of agricultural development. Investments designed to provide these institutional services need to be allocated accordingly.

## FOOTNOTES

1. Papers by Schultz [37], Falcon [14], and Wells [42,43], among others, are examples.

2. Schlicher Van Bath [35] also describes periods of relatively rapid increases in agricultural productivity in western Europe which occurred between 500 and 1850 A.D. These increases, he contends, were a consequence of changes in (1) population (2) political and economic organization, and (3) the level of agricultural technology. See also White [45].

3. Owen [29] describes two different mechanisms for organizaing production and distributing income -- the "Marx Lennist" Model and the "Mill-Marshallian" Model. Under conditions where the latter mechanism is employed, Boulding and Singh [7, pp.30,33] contend that "the object of price policy for developing society should be to some extent to anticipate the price structure of the developed society and to create it artificially in the hope that it will turn out to be self-justifying. The price system is simply a stimulus to which there can be more than one response. The differentiation among the responses, therefore, must be provided by other stimuli. Institutional changes constitute a most powerful means of influencing behavior response."

4. Polyani [10] has written extensively on this subject.

5. Higgins [16,p. ix] observed, "There seems to be in the history of each country an 'optimal moment' for launching development, a short period of time when sociological, political, and economic factors coalesce to provide a climate unusually favorable for a take-off into economic growth. If such an optimal moment is missed, it may take several generations to reproduce a

similar set of circumstances."

If development horizons are reduced in time, the amount of time required to reachieve a "once missed" optimal moment may be considerably less than several generations. Nevertheless, the idea that optimal moments for launching development come and go seems to be valid and useful. Ensminger [13] describes conditions in India in 1971 as perhaps being at such a stage. In the same vein Adleman and Morris [11, p.1212], on the basis of a rigorous quantitative analysis, concluded that, "the important impediments to increasing the capacity to develop are social and political as well as economic."

6. See Wunderlich [47] and other papers presented at the U.S. Agency for International Development Spring Review, Washington, D.C., May 1970.

7. Falcon [14, p.706] notes that, "It is not an accident that journals and newspapers are now frequently carrying such essays as 'Green and Red Revolutions' [26]."

8. The problem of the small tenant farmer is an additional dimension to this problem. Land being a scarce resource in many developing countries, much of the increase in income from adoption of new production technologies may be capitalized into the scarce resource, land. Owners of farmland will have incentives to increase land rents or to seek alternative managerial arrangements for farm production. In either case land is scarce while potential tenants and laborers are not. Consequently, the tenant, in a disadvantaged bargaining position, may obtain little benefit from the introduction of modern farm practices.

9. The speed with which an innovation is assimilated by firms within an industry depends on the technological system into which it must fit [34]. Where farmers must make large adjustments in their use of credit, irrigation

and capital, the cost of adoption may be high. On the other hand, where the required readjustments are small, the cost of adoption may be trivial. Consequently, the high-yielding varieties are most easily adopted when the cost of their adoption is low. The presence of a highly developed farm resource base reduces the cost of adopting, but where the new varieities can fit into less well developed production systems, the cost of adoption may also be small. In the latter situation, the contribution of the innovation tototal output is apt to be smaller than in cases where the production system is more highly developed. Their adoption, however, may provide incentives for other improvements in the production system at a later time. The authors are grateful to Harold Breimyer for drawing this to their attention.

10. Maharashtra is an extreme example of the lack of conditions necessary to achieve marked increases in farm output. While there are a few other states in which resource availabilities are similar to those in Maharashtra, there are also many in which rainfall and irrigation make the new farm practices more widely applicable. Further, regardless of the level of development of a particular region, there exist within each region (state) substantial differences among districts (counties) in the level of resource availability and agricultural development (38).

11. The stimuli for labor movement from rural to urban areas is described above in terms of a general oversupply of farm labor relative to demand. The problem is also related to the distribution of production resources within the farm sector. Persons most apt to migrate from rural to urban areas are landless and semilandless laborers. Some writers (e.g. [41] ), who emphasize this latter facet of the problem, suggest that land redistribution

may do much to minimize population movements from rural areas. This may be a feasible policy instrument where there are productive land resources to redistribute. However, where (1) there is relatively little land to redistribute or (2) that which is redistributable has low production potential, this instrument will have little effect.

12. Dandekar and Rath [11,p.32] concluded that the level of rural poverty (measured in terms of distribution of per capita consumer expenditures) was no worse in 1968/69 relative to 1960/61. In urban areas, however, mean per capita consumer expenditures declined during the same period. This narrowing in rural-urban income disparities is largely due to increases in the number of urban unemployed. This is, in turn, partially a result of migrations from rural to urban areas.

13. In the United States, this problem has been acknowledged only recently--the regional development commissions were not established until the early 1960's. The problems associated with regional disparities in per capita income and the income problems of the small farmer did not receive major attention in this country, because, in each case, the number of persons affected were small relative to the total population. See [31]. In the developing countries, these problems are apt to be more severe because: (1) the number of persons affected are apt to be large and (2) through the intervention of public sector institutions the time required for these problems to assume major proportions has been reduced.

14. For a somewhat different emphasis from a Latin American perspective see [41].

15. Further clarification of what is meant by a small farm is needed. While it is not clear where the dichotomization occurs, there is some point

where the amount of land cultivated becomes so small as to make that farm incompatible with a commercial agriculture. From the standpoint of a farmer's ability to adopt new production technologies; this distinction is important, because the use of these practices also implies the use of purchased inputs. To obtain the cash needed for their purchase the farm operator must produce some volume of output for commercial sale. Consequently, insofar as the amount of marketable surplus is related to farm size, so also is the ability to adopt modern production practices.

Many small farmers are essentially landless or semilandless laborers who depend primarily on wage employment for their income [39, p.4]. Consequently, for this group the welfare effects of the production technologies will dpend largely on the employment and wage effects for hired labor.

Nevertheless, there are a large number of persons with farms that, while above this conceptual minimum, are small. It is to farms in this latter group that the data in the text refer.

16. Irrigation equipment, and certain harvest implements (e.g. reapers and threshers) are not in themselves easily devisible. However, small farmers in some areas can purchase water from neighbors at rates slightly greater than the marginal cost of pumping [46]. Also, farmers in some areas in India are beginning to share the use of wheat threshers. Thus, even though many small farmers cannot afford to purchase some of the implements associated with using the new production technologies, a fractionization of implement services is possible my means of custom operations [40, p. ].

Also, the development of a public irrigation system requires a large initial capital outlay, and in this sense is a lumpy input. Nevertheless, the cost of developing and operating public irrigation systems as well as

the related services can be opportioned among farms of all sizes within the area served.

17. Reportedly, small farmers adopted these practices more slowly than larger farmers. That small farmers adopt innovations less rapidly than large farmers is well documented [34]. In Punjab, however, the relatively slower rate of high-yield wheat adoption by smaller farmers may be partially explained by a short run increase in the price of seed wheat. In 1965/66, the demand for high-yield wheat seed greatly exceeded the supply. Reportedly, only large farm operators had personal acquaintances with the right people or sufficient cash reserves to purchase these seeds at the extremely high black market price for high-yield wheat seed. By 1967/68, the supply of high-yield wheat seed had increased sufficiently so that this seed was available to all farmers at a price only slightly greater than the actual market price for wheat.

18. Also noteworthy is the fact that labor as a percent of total expenditures per hectare is lower on farms using new varieties and related inputs than on farms following more traditional practices. The large absolute and relative increases in the use of purchased inputs (seed, fertilizer, irrigation, etc.) permits large absolute increases in the use of farm labor without requiring that the factor share of labor also increase (the amount of labor relative to the total package of production inputs).

With respect to its employment problem, India faces the double dilemma of obtaining simultaneous increases in: (1) real wages in agriculture and (2) the number of real farm employment opportunities. Changes in wages paid to farm labor depend on changes in the productivity of labor. Changes in the productivity of labor, in turn, depend partially on changes in the aggregate factor share of labor. An increase in the factor share of labor does not

necessarily imply the direction of change in labor productivity. Nevertheless, an increase in the factor share of labor tends to offset other forces which increase labor productivity and hence wages.

If the factor share of labor declines, the ability of the farm sector to productively absorb more farm labor is compromised. This is because the rate of expansion in agricultural production is constrained by the rate of increase in aggregate demand for farm products. If the factor share of labor in agriculture declines more than in proportion to the increase in aggregate demand for farm products, farm employment opportunities may not increase.

In India, however, unlike the United States, land is dear and labor is cheap. New inputs being introduced into Indian agriculture tend to substitute for the scarce input (land) rather than labor. Lessons from Japan and Taiwan are instructive on this point. Substituting for land, increased use of biological capital in these countries permitted simultaneous increases in: (1) agricultural output, (2) farm employment, and (3) farm labor productivity [8, 20].

19. That many farmers are employed for less than some normative full employment year may stem from two somewhat different factors. The first stems from the fact that included in the number of farm cultivators are many small farmers whose land holdings are so small that the major source of income is from wage employment [39, p.4; 11, p.13]. These persons, while classified as farm cultivators, are actually semilandless or landless laborers (cf. ante. fn. 15). A related aspect of this phenomena are those farmers whose land has only limited production potential. Farmers cited in Maharashtra are illustrative of this.

A somewhat different factor stems from the tendency of many farmers, particularly large farmers in south India, for a variety of reasons, to avoid manual labor. As a consequence, the reported existence of a large potential supply of family labor based on aggregate measures of average farm employment by farm operators relative to some normative measure of a full employment year may overstate the actual supply of family labor.

20. Using data from 150 farms in each district the following employment model was tested using multiple regression procedures.

$$L_f = \phi\ (X_1, \ldots X_n,\ L_p,\ L_c)$$

$$L_p = \phi\ (X_1, \ldots X_n,\ P_{Lp},\ L_f,\ L_c)$$

$$L_c = \phi\ (X_1, \ldots X_n,\ P_{Lc},\ L_f,\ L_p) \text{ where,}$$

$L_f$, $L_p$, and $L_c$ are the number of man-days of family, permanent, and casual labor employed per year, respectively; $X_1, \ldots X_n$ are the quantities of other production inputs employed per farm; and $P_{Lp}$ and $P_{Lc}$ are the daily wage paid permanent and casual labor, respectively.

Permanent labor is that labor which is employed on farms on a full time basis. Casual labor is employed only during periods in which the demand for farm labor exceeds that supplied by family and permanent labor. For details see [39].

21. On the other hand, the introduction of tractors on large Indian farms may create economic forces which induce farm consolidation, in absence of public sector intervention, and within the limits imposed by the relative differences in the price of labor and capital, these forces could lead to a capital intensive--labor extensive agriculture in areas like the Punjab. While the results described in the text suggest that tractor

adoption has not seriously jeopordized farm employment opportunities in Ferozepur, economic forces related to their adoption which encourage farm consolidation may. This problem is not apt to be as serious in India as in other countries because laws regulating maximum farm size have already been implemented in most states.

22. In any event, the aggregate effect of tractorization on farm employment may be quite small. This is because the vast mojority of Indian farms are small and small farmers have difficulty making efficient use of tractors. For example, in the Ferozepur sample, tractors were commonly owned on farms of 25 hectares and were not present on any farms of less than 12 hectares. In Punjab, less than 20 percent of the farms exceed 10 hectares and in other states the proportion is considerably smaller. Small farms can, in theory, rent tractor services. However, with only a small portion of the farms large enough to economically purchase farm tractors, the supply of tractors available for custom services is apt to be considerably smaller than the potential demand for custom tractor services.

The possibility exists that specialized custom tractor firms could be organized to meet this demand, as has been the case in Thailand. To date, however, they have not become conspicuous on the Indian scene.

23. A notable exception is Schultz (36).

24. Hayami and Ruttan (20,pp.1124-1126) illustrate the application of this principle with comparisons between the United States and Japan. In Japan "the opportunity arising from the declining price of fertilizer relative to the price of land was exploited through biological innovations. Seed improvements were directed to the selection of varieties more

responsive to fertilizers." In the United States, "a decline in the prices of land and machinery relative to wages encouraged the substitution of land and power for labor...this substitution generally involved mechanical innovations."

In both countries the generation of the respective kinds capital (labor saving or land saving) were the product of public sector research and development. In each case, the services provided by the public sector institutions enabled agriculture to maximize the returns obtained from the scarcest resource.

25. The country is more heterogeneous than the use of these three regions would lead the reader to believe. Further, the proposal is framed in terms of reallocating public development resources to increase the productivity of farmers in regions where the new production practices are not applicable. Even within areas where the new practices have had some impact, there are some farms on which these practices cannot be adopted because the supply of water or some other resource is lacking. Consequently, the examples used here, while useful in describing a public sector investment strategy, abstract somewhat from the specific nature of the disparities in production opportunities among and within regions.

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