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INCOME DISPARITIES IN THE AGRICULTURAL SECTOR: REGIONAL AND INSTITUTIONAL STRESSES

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INCOME DISPARITIES IN THE AGRICULTURAL SECTOR: REGIONAL AND INSTITUTIONAL STRESSES

Donald K. Freebairn

The central concern of this paper is a review of the relationship between equity and development. It seems fair to say that technological and economic considerations have been the dominant ones in the systematic study of development over the past twenty-five years, and at least with respect to the intervention of economists, theoretical formulations have emphasized rapid growth at the expense of a wide distribution of the benefits. Growth models emphasize capital accumulation and provide for disparate income levels, assuming behavior patterns which permit the transfer of a significant fraction of high personal income into investment capital. And, of course, these models have had a direct influence on development policy formulation.

As far as development of the agricultural sector is concerned, no single breakthrough in recent years has had the impact of the "green revolution," with its technological definition and with the corresponding economic and social influences. The thesis of this paper is that the technology of the high yielding varieties systems as employed in practice and as facilitated by national and international agencies exacerbates the already substantial income inequalities among agricultural populations. In this respect the technology operates in two fundamental ways: first, the technology is highly selective in adaptation to particular ecological zones and second, because of technical

requirements it operates to distort even further the inequitable distribution of income and wealth within the favored zones.

In its simplest form, the high yield varieties technology is a scientifically developed procedure for growing a crop in a manner distinct from traditional and established farming practices, and which results in yields substantially greater than the traditional methods. While it is essentially a biological process, its implementation and facilitation have important political, social and economic aspects. The most basic elements of the improved technology include a defined calendar of operations, thorough land preparation, use of genetically improved seed, precise and significantly higher chemical fertilization programs, water control, and plant insect, disease, and other pest protection.

On the surface there appear to be no significant elements in the improved production system that cannot be employed on the smallest as well as the largest farms in the favored production zones. Nevertheless, in his introductory statements at the beginning of an international conference on the Puebla Project in August, 1970, Dr. E. J. Wellhausen, Director General of the International Maize and Wheat Improvement Center, pointed out clearly that the green revolution had moved ahead on its own momentum, primarily among the larger, more commercially-minded and well-established farmers.[1] He pointed out that Mexico's wheat production is concentrated in the irrigated valleys of the Northwest

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[1] E. J. Wellhausen, "The Urgency of Accelerating Production on Small Farms," Strategies for Increasing Agricultural Production on Small Holdings, CIMMYT, Mexico, 1970.

and somewhat in the Bajio; the improved technologies in corn production have been adopted in the areas with the best rainfall and by the larger and more commercially oriented farmers. Even sorghum grain, which has the capacity to grow in dry regions with variable rainfall, is grown on large commercial farms, in the better natural rain-fed areas, or even under irrigation. We note also that Brazil has enjoyed considerable success in modernizing parts of its agricultural sector, particularly in Sao Paulo and the Minas Triangle, and has made important advances in the systems of maize production using internationally known and developed technologies, but little has been done to alleviate poverty in the rural communities of the Northeast. Guatemala, Ecuador, Colombia and Peru have all made important progress in modernizing elements of their agricultural sectors, but in almost all cases the advances have been selective. Guatemala has increased corn production, in the Pacific lowlands, to meet urban demand, but the mass of the rural population live in the highlands. Colombia emphasizes research work in its rich valleys and lowlands, but most of the rural people live in the highlands. In a similar manner, Ecuador is concentrating its production efforts in a few favorable valleys and in the Pacific coastal areas, yet there too most of the rural people are located in the highlands. Both Peru and Bolivia are making progress in supplying their rapidly expanding urban populations, but the larger rural subsistence sectors in the highlands are being bypassed. Throughout most of Latin America, the tendency has been to concentrate the modernized and technical agricultural production systems in the ecologically more favorable areas and with the better situated farmers.

While the structure of agriculture in Asia is in many respects distinct, the consequences of modernization are not all so different.

Inter-Regional Disparities

The physical resources available to a community or a region will largely determine the potential for benefiting from the high yield variety technology. Soil, climate, topography, irrigation facilities, population densities and market location all vary between regions, and these physical and locational factors in part determine the relative success of the new technologies. The two most significant breakthroughs over the past 25 years have been the development of the new wheat and rice production systems. A look at the adaptability of these systems may help to clarify the effects on farm income growth between geographic regions.

Rice

If we look at rice and confine ourselves to the Asian countries (excluding China) we can note that in the late 1960's approximately 81 million hectares of land were planted to rice.[2] While there seem to be no studies which directly define the areas in which the new varieties may be used, there is some work reflecting the rate of adoption of the new varieties. Barker and Mangakas, in a paper presented at the XIV International Conference of Agricultural Economists, discuss the environmental factors influencing the performance of high yielding

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[2] IRRI, Rice Research and Training in the '70's. Los Baños, Philippines, 1970.

varieties of rice and wheat in Asia.[3] While their paper principally explores the comparative growth in use of the new varieties, it does provide useful insight into the potential areas which can receive the benefits of the newer techniques. The authors point out that most rice is grown under conditions of seasonal rainfall and where there is an absence of adequate water control; plantings are subject to the risks of both flood and drought. Up to the present time new varieties have not been developed which significantly help either the upland or deep water rice growing regions. Adoption of the improved systems in the rain-fed wet-rice areas, although technically feasible, does not offer the potential differences in yield that hold under favorable irrigation conditions. In addition, since the improved systems require substantial purchased inputs, the uncertainties about water supplies inhibit cultivators in the rainfall areas from risking their precarious domestic ecnomy by adopting the system. Barker and Mangakas give the following estimate of rice planting area (by land type) for South and Southeast Asia:

Land Type	Effective Crop Area	Production
Irrigated		
Single cropped	10%	15%
Double cropped	10%	25%
Subtotal	(20%)	(40%)
Rainfed:		
Deep water	10%	8%
Other	50%	42%
Subtotal	(60%)	(50%)
Upland	20%	10%
TOTAL - All areas and production	100%	100%

[3] Randolph Barker and Makar Mangakas, "Environmental and Other Factors Influencing the Performance of New High Yielding Varieties of Wheat and Rice in Asia." Mimeographed paper presented at the XIV International Conference of Agricultural Economists, Minsk, U.S.S.R., August 24-September 2, 1970.

For the rice technologies which are now available, only twenty percent of available crop lands have ecological conditions favorable to adoption. While future work is programmed which may broaden the production zones that can benefit from the new technologies,[4] the work to date has been highly selective in terms of regions with potential to receive the principal benefits.

Wheat

The favorable environmental requirements for the application of the high yielding wheat varieties systems of production are quite comparable to those for rice. The systems have been designed for application under irrigation, although they can be applied in a few production zones with highly favorable natural rainfall. For the areas under our current purview, these requirements are less limiting with respect to regional adaptability than for rice, which is by far the more dominant crop. Wheat is grown almost exclusively under irrigation in South Asia and, of course, hardly at all in Southeast Asia. Out of the approximately 22 million hectares of base area sown to wheat in South Asia, an estimated 9.4 million hectares were planted to the improved varieties in 1969-70.[5] This means that well over 40 percent of the wheat lands have incorporated the improved system, and expansion still continues at a rapid pace. This rapid adoption is not unlike the experience of Mexico in which the improved varieties reached 90 percent and more of wheat

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[4] IRRI, op. cit.

[5] Dana G. Dalrymple, "Imports and Plantings of High Yielding Varieties of Wheat and Rice in Less Developed Nations," Foreign Economic Development Report No. 8, U.S.D.A., 1971.

acreage a few years after introduction.[6] The circumstances in West Asia and North Africa are distinct with respect to the ecological conditions under which wheat is grown. In these regions only about 6 percent of the wheat plantings were reported sown to the improved varieties last year. It should also be pointed out that the great majority of the world's wheat supply is produced under natural rainfall conditions, albeit for the most part in the more well developed countries.[7]

On balance, even for those crops on which substantial progress has been made, the great majority of the production regions in developing countries are standing to the side while others gain competitive advantage through the application of the modernized production systems. And, while it is difficult, and, with the data currently available, perhaps impossible to put exact numbers on the share of regions and agricultural populations obtaining direct benefits, it would be hard to imagine with current agricultural techniques a potential advantage in the intermediate term according to more than 20 percent of the production regions. It is somewhat uncertain whether or not populations would be denser in the favored regions of water control, but they would probably not be.

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[6] Delbert Myren gives an excellent report on the locational differences and quality of land as explanation of the differential histories for the spread of wheat and maize production systems in Mexico, "The Rockefeller Foundation Program in Corn and Wheat in Mexico," in Clifton R. Wharton (editor) Subsistence Agriculture and Economic Development He details the geographical shifts in location of wheat production, resulting from the improved production systems designed for the irrigated areas at the expense of wheat plantings in the non-irrigated high valleys and northern plateau regions.

[7] The 1968 F.A.O. Production Yearbook indicates that less than 20 percent of the world's wheat production occurs in Latin America, Africa and South, Southeast and West Asia.

Institutional Stresses

Equally significant are those institutional structures and forces and the technological requirements of the production system which jointly serve to discriminate in the distribution of benefits between social groups within the favored regions. In the short-to-intermediate term periods of a new and significantly more efficient production system, the early adopters are able to capture a significant surplus profit when the innovation affects a product which has either a massive market compared to the amount produced in any production zone, or is imported in significant quantity. While we cannot say with certainty what the long-run effects in the distribution of gains of technological improvements might be between producers and consumers because these will be dependent on the relative demand conditions facing producers as a whole and their relative bargaining position vis à vis political power, we can expect in a market-oriented society, except under the most unusual of conditions, that early participants will reap substantial net gains. Not only this, but in a dynamic context, those who have felt the benefits of advantage reasonably can be expected to make every effort at consolidating those benefits and using them in part to perpetuate the favored position.

Land Ownership

The most obvious of the factors determining who will receive the benefits is who owns the land. In low-income agrarian societies, a great majority of the organizing institutions of the society center around the ownership of land. Classical economics attributes to land

the role of residual claimant after all other factors have received their payment in accordance with their productivity at the margin or at their opportunity cost in alternative uses. For the short-run, land owners would be expected to receive much of the surplus profit from the innovation. Without for the moment doing any more than make passing mention of the complex influences which the innovation may have on the distribution of production benefits between producers and consumers, it is possible to identify, at least conceptually, the narrowing band of producer beneficiaries. Even in the highly populated regions of Asia, where numerous forces and much time have worked to break down excessive concentration of ownership, it is estimated that up to a third of the labor force dependent on agriculture are landless workers. Admitting that at least some from this group may find more days of employment with the new technologies than was true before, there is little reason to expect that their wage rates or position in the labor force will be significantly enhanced.[8] In fact, there are indications that a corollary of the high yield varieties is a strong facilitation for mechanizing agricultural operations; the model for modernizing agriculture is largely that of the United States and Western Europe, both of which enjoy world fame for their technical and mechanized

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[8] Mr. Richard Critchfield, on leave from the Washington Evening Star and a traveling fellow of the Alicia Patterson Fund, was asked to reflect on the meaning of the "green revolution" when Dr. Norman Balang was awarded the Nobel Peace Prize. His letter from Jakarta, RC-10, October 30, 1970, of the Patterson Fund series, reviews the forces at work tending to displace agricultural workers in the villages of Punjab and in Indonesia. He vividly points out how the shifting productic economy of the high yield varieties works to break down an evolved system of mutual rights, obligations and responsibilities; the new systems although more efficient and seemingly more economical undermine village social welfare systems established over centuries.

agricultural systems. The application of biological science and mechanical engineering operate hand-in-hand in these examples, and to most observers the demonstration effect of modernized agriculture means the introduction of both elements. In most countries encouraging agricultural modernization, there are arrangements and institutions subsidizing the introduction of mechanical power at the expense of employment, although it must be recognized that, particularly in areas of multiple cropping, the precise calendar of operations between harvest and the following planting provides such a short time period that farmers may be forced to use mechanical cultivation.[9]

Information Networks

But, the institutional arrangements are far more pervasive than just who owns the land; there are numerous concommitant elements. The high yield varieties technology is exigent in the precise application of science to the agricultural production processes, and this precision makes access to the work of the scientists of extreme importance. Tying into the networks of the experiment stations and the extension service is essential if a farmer is going to be able to gain the maximum benefits not only from the first application but just as well from the succeeding generations of improved practices. The largest benefits

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[9] A short news report in the New York Times on November 1, 1970, reported that Pakistani landless and jobless are being increased by the green revolution. The opening line states that a farmer having received his new $4,500 tractor is releasing his threetenants -- he does not now need extra labor. The news report quotes a West Pakistan Planning Commission official to the effect that full mechanization on farms of 25 acres or more could displace 600,000 to 700,000 workers in 15 years. It further cites that the number of tractors in Pakistan has gone from 3,000 in 1960 to 20,000 in 1969. While it is true that both this and the Critichfield citation are journalistic reports, they represent a very real interpretation of the perception of peasants and officials in the regions affected.

have been reaped by those who get into this kind of improving technology early in the game. In northwest Mexico, where much of the new wheat technology was first worked out, farmers learned that there were enormous rewards for the early users. If they could manage to be the first entrusted to produce a new variety, the reward was double: in the first place, they had higher yields than were possible before; and second, they were often able to sell their crop as seed for later adopters at much higher than commercial wheat market prices. These opportunities were afforded to those farmers who travelled, who knew exactly what was going on, who read farm magazines, who visited the experiment station, who consulted with the technicians working on improvement problems, and who were respected members of the community. While it is true that these men were important and often larger landowners, they were more than just that; involvement in the process requires more than just owning land. An important fraction of the lands in Northwest Mexico are owned by the ejido sector, yet this factor of land ownership has not in and by itself been enough to guarantee a wide participation in the progress and rewards of the bountiful agriculture of this zone.[10]

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[10] I do not forget having been in the Yaqui Valley, Sonora, Mexico, in the Spring of 1963 when the regional experiment station (CIANO) held its annual field day. Thousands of farmers from all over the Northwest attended, but what was most notorious to me on that occasion was a full page announcement in the local newspaper in which the leading ejido sector leader signed in the name of his ejido a note of gratitude to the experiment station for having for the first time invited the ejidal sector to participate in the field day; this, although similar field days had been held for close to 15 years and the region had obtained international renown for the results of applied research and their incorporation into farming practices.

Resource Development

It was mentioned earlier that water control is one of the most critical factors in the high yielding varieties technology. The practices which must be followed involve substantial purchased inputs, and unless farmers can depend on an assured supply of water, the risks of investment are far too high. The rapid expansion of private tube-well installations in South Asia and the Philippines in the past five years is testimony to both the requisite nature of water in the modernized farming systems and the expected profitability of the package of practices. The area irrigated by tube wells is reported to have increased in West Pakistan from less than 200,000 acres in 1956-57, to 2,450,000 acres by 1966-67,[11] and in India from 7,083,000 hectares in 1959-60, to 8,445,000 hectares in 1965-66;[12] the number of tube wells installed by the Philippines Irrigation Service Units increased from about 600 wells in 1964-65 to over 5,000 wells in 1968-69.[13]

Farmers who know how to modernize their farming systems and who can make arrangements to carry out the improvement plan have been richly rewarded. Mr. Charles Robertson studied tube well irrigation in the Philippines in 1970. His study details a number of salient points.[14]

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[11] Government of Pakistan, Central Statistical Office, Pakistan Statistical Yearbook 1968. Karachi, January 1970, pp. 136 and 146.

[12] Government of India, Central Statistical Office, Statistical Abstract: India 1968. New Series No. 16. New Delhi, p. 100.

[13] Charles Robertson, unpublished thesis draft, "Economic Analysis of Ground Water Irrigation in Nueva Ecija, Philippines," Ithaca, 1971, p. 11.

[14] Ibid

In the first place, investment in well irrigation systems can be a highly productive activity; the internal rates of return in the Robertson study area in the Philippines were estimated to have a potential of more than 30 percent under favorable conditions, and even higher for shallow wells. A second feature of pump irrigation was the rapid expansion over the past several years noted above, and the tendency for Philippine farmers, particularly those with larger farms to make the investments notwithstanding the relatively unsuccessful program of the Irrigation Service Units when this agency worked with the Farmers' Association in promoting tube wells.

Robertson presents interesting partial evidence concerning the distribution of the surplus profits. In Nueva Ecija, Philippines, and under a traditional 50-50 share-cropping system, the introduction of a shallow well was estimated to increase gross income per hectare by 858 pesos in the dry season and by 304 pesos in the wet season. (This compares to an expected 800 pesos per hectare annual gross without irrigation.) Thus, when landlords and tenants share the extra cash costs, of operating the pump, the tenants receive a significant part of the benefits of the new technology, with only modest additional labor inputs. Under cash tenancy, the landlord is able to charge for some fraction of the capital costs of the irrigation investment, and the tenants' share drops proportionately. The Philippine Agrarian Laws provide for the elimination of sharecropping with the substitution of cash rentals, owner cultivation, or owner administration. Although not well documented in this study, there is the suggestion that large farmers who are in strong capital positions and who are able to provide the

requisite management are shifting as much of their farms as possible to direct administration, thus more nearly capturing the full advantage of the modernized production system.

Even the nominally private investments in water development have significant public aspects, whether they are in capturing a fraction of the flow of the water which is then not available to others, or in the direct and indirect subsidies so often associated with resource development. And, of course, the publicly-developed projects usually have important elements of subsidy involved. Access to these increased resources is often biased in favor of larger and commercially oriented farmers and to the indirect expense of small owner-operators, tenants and landless workers.

Agricultural Credit

Involvement of small farmers and tenants in the improved technology depends importantly on the availability of credit. As we have pointed out, the requirement for adequate water control in order to use the high yield varieties technologies has created a demand for tube wells and low-lift pumps. Notwithstanding the rapid payoffs for investments in water development, the initial capital requirement is high and often beyond the means of small farmers. We mentioned the profitability of well installations in the Philippines; there, a shallow well with pump represents about US$1,000, and can earn an estimated 30-70 percent internal rate of return. For small farmers, provision of this kind of capital is usually dependent on credit; in many instances, larger farmers with other business or professional interests are able to directly finance even the far more substantial investments of deep wells

without recourse to credit institutions. But if the objective is to incorporate as many small producers as possible into the modernized production systems, it is necessary to facilitate the development of their resource base.

Of course, additional working capital, particularly for fertilizers, must be financed. Both institutional credit and traditional village-level sources are able to make some contribution toward satisfying the needs, although small farmers have limited access to the amounts and forms needed to modernize their farming systems.[15] Two important factors are at work tending to limit the expansion of credit for small farmers. The first is the cost of the credit; increased administration per dollar loaned and the presumed increased risks associated with small loans make the cost of supplying credit to small farmers higher than it is to large farmers. Since interest rates for institutional leaders are either fixed by law or custom, the extra costs bite into profits; since the total amount of funds available for lending is always short, managers show more profitable operations by selecting larger farmers who can both borrow in larger units and who offer lower risks of losses. The second factor centers on the structure of credit institutions. Commercial banks, cooperative credit societies and public agricultural banks are linked to that segment of the rural society which has access to the networks of technical knowledge, the physical resources of land and water and political clout. It is hardly surprising that these same farmers are the principal credit clients.

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[15] For example, less than 10 percent of Mexico's farmers have access to institutional credit. Donald K. Freebairn, "Prosperity and Poverty in Mexican Agriculture," Land Economics, February 1969, pp. 36-37.

Employment

I have alluded above to the possible displacement of workers in the application of the high yield varieties production systems; the importance of providing employment opportunities in low income countries with rapid population growth rates, makes it mandatory to consider more explicitly the employment ramifications of rapidly modernizing agriculture. A number of basic elements work to make the modernized systems capital as contrasted to labor-intensive -- dependence on irrigation, chemical fertilizers, pesticides, and other capital-oriented inputs; multiple cropping with rigorously defined calendars of operation tending to force mechanization of farming operation; and, the demonstration effect of the world's already modernized agriculture with its capital-intensive and labor saving format.

The off-setting elements are the degree to which multiple cropping will tend to compensate for the displacement of agriucultural laborers by more mechanized production systems and the jobs which may be generated to service the modernized agriculture. Although there may not now be very satisfactory estimates of the balance to be drawn, there are a few interesting studies which suggest the direction of the answer, although, unfortunately, there is little on the question of agriculturally indused industrial employment. One effort is directly related to the employment effects in the rapid assimilation of the green revolution, the study being based on data and circumstances in the Punjab, India.[16]

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[16] Martin H. Billings and Arjan Singh, "Employment Effects of HYV Wheat and Its Implications for Mechanization," Agricultural Economics Division, USAID, American Embassy, New Delhi.

Billings and Singh divide farming operations into four categories in order to evaluate the potential for mechanization and the probable influences on employment; the categories are seed bed preparation, irrigation, interculture, and harvest. They also distinguish the effects on family labor, permanent employees, and day laborers. In the region of the Punjab, farmers (including tenants) tend to give personal attention to the details of seed bed preparation, particularly if a tractor is being used. Mechanization of land preparation and seeding would effect few non-family workers, although resident landlords might tend to release tenants and take a more active role in farming operations. Irrigation operations on small and intermediate size farms are also largely done by family workers, and the use of power to draw water will tend to release children and women from the burden of handling pumping operations. Interculture is a labor intensive part of the farming program; at the present it is the least likely to be effected by mechanization, and the new technologies will have the least effect on labor requirements. The most labor intensive activity in wheat production has been harvesting. Mos farms, both large and small, use day labor in the cutting and threshing. The much higher yields resulting from the improved techniques have placed a heavy demand on labor and has even caused shortages. By 1969 Billings and Singh estimated that one-half of the Punjab wheat was threshed mechanically, and they estimated almost all would be by 1974. The introduction of mechanical harvesting will eventually result in an over-all decrease of about 90 million man-days of employment in the Punjab, most of it for day laborers.

It is clear that the combination of extra energy needed to handle the improved single crop and to cope with the potential for multiple cropping, forces a need for much greater quantities of energy than that available from conventional sources. In the Punjab farmers have responded by increasing over the last five years the number of pump sets from 66,000 to over 100,000, mechanical threshers from 5,000 to about 100,000, the number of tractors from about 8,000 to 20,000. This kind of growth is likely to continue into the future.

Billings and Singh study the influence of tractor cultivation on employment demands for different rotations in the Punjab. For each of seven rotations studied, a modernized production system using a tractor, pump set, high yield varieties and fertilizer, reduced per acre labor requirements from 20 to 30 percent below those for traditional farming systems, with the incidence falling most heavily on family labor -- some of which might be absorbed in marketing and distribution activities. And, of course, mechanized multiple cropping can absorb more labor per unit area of land than non-mechanized single crop farming.

A quite different study in the Moquequa Valley in Southern Peru explored the economic feasibility of introducing an intensive horticultural cropping system into a traditionally-oriented small holder farming system.[17] The shift from extensive production of grains to intensive horticultural crops multiplied gross incomes almsot four fold and greatly increased factor returns; it did not, however, provide much

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[17] Lon C. Cesal, "Economic Viability of Minifundio Farm Units: A Case Study of the Moquequa Valley in Peru," unpublished manuscript.

greater employment. While capital requirements increased two to three times over the traditional farming requirements, the labor requirement only rose 20 to 30 percent.

The Cumulative Effect

Rapid technical progress in agriculture has the capacity to increase significantly the amount of agricultural product; successes in Mexico, India, Pakistan and the Philippines in recent years serve as indicators of the results which can be expected. At the same time, the technologies, with their implicit implementing policies, seem to work toward heavy concentrations of potential benefits. Without being able to specify numerically the degree of concentration, the larger sized landowners in the favored ecological zones combine the connection with the information networks producing the improved technology with control over the requisite resource base, and access to the production inputs and the means of financing them.[18] In addition, because of their social and political status, they can influence policies which enhance their own positions relative to those in weaker positions.

The Case of Mexico

Ideally, we would like to have detailed data on the shifts in income levels between regions, and between farmers within regions, which have been associated with the changes in technological systems. Unfortuantely, these kinds of data are not available, and considering the

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[18] Mr. Michael Schluter in an unpublished manuscript reviewing the relationships between the new varieties and farm size indicates that using data reported by the Agricultural Economics Research Centres he identified a positive correlation between adoption and farm size in the 20 areas studied and that the relationship was statistically significant at the 5 percent level for 17 out of the 20 cases.

postulated disparities which may be generated by modernizing selected agricultural regions, no government might reasonably be expected to set up such an inquiry; it is conceptually easier to measure the increase in tons of production, and such measures serve as testimony to effective development policy.

With the exception of Mexico, most of the countries which have been active participants in demonstrating the powerful production potential of a modernized and technical agriculture have been involved in the process for less than ten years. The case of Mexico is unique because it is now almost 30 years since purposeful and effective agricultural research was established. In addition, there, and in many other countries as well, the recent implementation of organized research and production campaigns are supported by a long record of interest in, and activities related to, improving the production base in agriculture. In a very real sense, the recent examples of success in production campaigns rests on investments in land and water improvement, advanced agricultural training and research, extension services, credit systems, and marketing, price and other supporting policies which have received the attention of national leaders for many years past. The present phenomenon rests on results which have been notoriously successful; the pieces have fit together better than ever before. The new appreciation of what is both important and necessary is the essence of the revolution.

The systematic modernization of Mexico's agriculture has been pursued over much of the past 50 years, and it has been pursued in an interesting and pragmatic way. On the one hand, the country has carried

out an extensive agrarian reform which incorporated well over two million families into the body of farmers with land holding rights; at the same time, it pursued policies of land and water development, transportation, agricultural technification, agricultural credit and price supports which have been designed to forge a new and modern agriculture at the periphery, rather than to transform the old and established.[19] A recent study on the Mexican economy provides an interesting view of the regional shifts in agricultural production and productivity.[20] The ranking in Table 1 indicates the notable shift downward of the heavily populated center region vis á vis the periphery. Notwithstanding the tenuous nature of production and population data in Mexican agriculture and the difficulties involved in making inter-temporal product values comparisons, the suggestion is of shifts from approximate equality of per capita agricultural production between the Center and the North Pacific at about US$ 24 in the 1899-1907 period to a shift upward by 1966 to about US$ 60 for the Center and to about US$ 220 for the North Pacific. The magnitudes in the shifts are sufficiently large so that modest changes in the data base would still not materially effect the conclusions drawn.

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[19] Donald K. Freebairn, "Relative Production Efficiency Between Tenure Classes," Journal of Farm Economics, December 1963, p. 1151.

[20] Clark W. Reynolds, The Mexican Economy, New Haven: Yale University Press, 1970, Chapters 3 and 4.

Table 1

Rank Ordering of Regional Per Capita Agricultural Production

In Descending Order	1899	1907	1930	1940	1950	1960
1	Gulf	Gulf	N. Pacific	N. Pacific	N. Pacific	N. Pacific
2	N. Pacific	Center	Gulf	Gulf	North	Gulf
3	Center	S. Pacific	North	North	Gulf	North
4	North	N. Pacific	Center	Center	S. Pacific	S. Pacific
5	S. Pacific	North	S. Pacific	S. Pacific	Center	Center

Source: Adapted from Table 3.4, Clark W. Reynolds, The Mexican Economy, p. 101.

The data given in Table 2 permit us to carry the argument a little further. The old and well-established Center area had the slowest rate of agricultural growth; it also had by far the slowest growth in agricultural labor force, land under cultivation and (except for the Gulf coast) in capital investment. The Center has, of course, been farmed intensely for hundreds, perhaps thousands, of years and, while land under cultivation between 1930 and 1960 almost doubled for the country as a whole, the expansion in the Center has been only about one-third. The labor force has also grown slowly in the Center with an approximate 50 percent increase between 1930 and 1960, compared to an almost doubling in the other regions. Direct investment in Central region agriculture has not been attractive, although it is important to note that productivity increases (residual, Table 2) have been higher in this region than in the Pacific North. A large

Table 2

Growth of Mexican Crop Production, Inputs, and Productivity
1929-59

Region		Index (1929=100)	Compound Annual Growth Rates
North	Labor	178	
	Land	223	
	Capital	894	
	Output	433	
	All inputs		5.0
	Residual		4.2
			0.8
Gulf	Labor	173	
	Land	223	
	Capital	278	
	Output	376	
	All inputs		4.5
	Residual		2.7
			1.8
North Pacific	Labor	215	
	Land	304	
	Capital	1,290	
	Output	537	
	All inputs		5.8
	Residual		5.6
			0.2
South Pacific	Labor	189	
	Land	271	
	Capital	461	
	Output	529	
	All inputs		5.7
	Residual		2.9
			2.8
Center	Labor	152	
	Land	135	
	Capital	340	
	Output	283	
	All inputs		3.5
	Residual		1.8
			1.7

Source: Adapted from Table 3.10 and 3.14, Clark W. Reynolds, The Mexican Economy, pp. 116-124.

fraction of this increased productivity in the Center may be due to the influence which urban infra-structural investments may be having on this region's agricultural economy.

An additional interesting phenomenon emerges from this data. Although the Pacific North region had the highest rate of expansion in output, it had the lowest increase in productivity among the several geographic regions. The almost 6 percent compounding rate of growth in output over a 30 year period is one of the highest which can be imagined for an agricultural region; but it has been accompanied by an almost corresponding growth in agricultural inputs. Most significant has been the heavy capital component. Capital inputs have increased over twelvefold between 1930 and 1960. By contrast, in the Pacific South, although still a relatively low-income agricultural region, the rapid rate of growth in output has been associated with much more reduced growth in capital inputs. Rather than the heavy capital demands of the technical and mechanized agriculture of the Northwest, the Pacific South has expanded production largely by opening new lands to cultivation, incorporating large elements of labor both in clearing new lands and in the agricultural production activities. The relatively low rate of growth in productivity, although a seeming anomaly to the casual observer of the beautifully-cultivated irrigation districts of Sonora and Sinaloa, has been identified and suggested in the published reports of a number of students of Mexican agriculture.[21]

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[21] Folke Dovring, "Land Reform and Productivity: The Mexican Case," AERR, University of Illinois, 1966; Donald Freebairn, "Relative Production Efficiency," op. cit.; and Richard Weckstein, "Evaluating Mexican Land Reform," Economic Development and Cultural Change, April 1970, pp. 391-409.

Considering the relative scarcity of capital for national development, the allocation of so much scarce resource raises serious questions about the strategy selected

We are still too early to have at hand even preliminary results from the 1970 Mexican Census of Agriculture, which is the only adequate source for documenting both regional and individual concentrations in Mexican agriculture. As a consequence, data from 1959 (the 1960 census) must be used. In an earlier study, I identified the degree of concentration in Mexican agricultural output among a handful of agricultural producers.[22] Over 40 percent of the agricultural marketings come from about 11,000 farms, or .3 percent of the nation's producing units. If you include a wider group of intermediate-sized private farmers and the better situated ejidatarios, you can account for three-quarters of the agricultural marketings coming from about 15 percent of the farming units. Mexican agriculture illustrates well the success in terms of supplying urbar centers and foreign markets, a set of policies which encourage bringing together the resources necessary to forge a new and modern agriculture where no agriculture existed before. Opening up new lands to cultivation, developing water resources, establishing research stations, providing transportation facilities, assuring the supply of the requisite inputs, building the credit institutions and assuring attractive markets for agricultural products have resulted in a responsive and modern agriculture. It has not, however, transformed traditional agricultural

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[22]Donald Freebairn, "Prosperity and Poverty in Mexican Agriculture," op. cit.

producers into model entrepreneurs and relatively prosperous peasant farmers. Rural poverty dominates the countryside; modernizing the periphery has not improved the welfare of the bulk of the nation's small farmers, *ejidatarios* and agricultural workers.[23]

The Implicit Views

Within the general framework of a market economy, three simplified views of the kind of national agriculture that might emerge come to mind: a classical Western European type yeoman agriculture; a highly modernized segment that supplies urban centers in association with a subsistence segment that serves as a holding area until the excess resources can be absorbed into non-agricultural activities; and a highly-modernized and small agricultural sector with surplus agriculturalists absorbed in urbanization projects. No one can say with any degree of certainty the direction which low income agriculture will take; it is quite likely that countries of differing circumstances will opt for alternative policies. But there are some underlying forces which will indicate the directions which may be forthcoming and which can provide insights, even at this early date, of the implications of the patterns of agricultural development which are now underway.

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[23] An increasing literature on income distribution is becoming available on Mexico; see, for example, Ifigenia M. deNavarrete, "La distribución del ingreso en Mexico," in *El Perfil de Mexico, 1980*, Mexico, Siglo XXI, 1970, pp. 18-71.

The central thrust of this paper has been that the implementation of the modernized agricultural systems has been highly selective in its application. We have noted the ecological and institutional restraints which have operated to restrict the number of producer beneficiaries. The question must arise as to mechanisms for successful implementation of improved agricultural systems among small holders and, in essence, the possibilities of building a viable and even prosperous peasant agriculture. Is it adequate to develop a number of new technological breakthroughs and formulate a series of public programs which will facilitate widespread adoption, or is there a more fundamental limitation to the establishment of a progressive and prosperous peasant agriculture in the low income countries?

At least one major experiment is currently being carried out attempting to study the possibilities and potential for carrying the benefits of a technified agriculture to small farmers -- the Puebla Project.[24] This undertaking, located in the state of Puebla, Mexico, centers its attention on finding ways to incorporate small farmers into the dynamic and growing national economy through the instrument of a technically improved maize production system. The project started in 1967 with 30 participants; by 1970 there were almost 5,000 farmers organized into 200 groups working in the project, and

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[24]The conception of the project, a description of the area, the organization of the undertaking, and the first two years' results are documented in detail in The Puebla Project 1967-69, CIMMYT, Mexico, 1969. Additional descriptive material and the results up to 1970, are given in Leobardo Jimenez Sanchez, "The Puebla Project: A Regional Program for Rapidly Increasing Corn Yields Among 50,000 Small Holders," in Strategies for Increasing Agricultural Production on Small Holdings, CIMMYT, Mexico, 1970. An Economic Analysis of the project is presented by Delbert T. Myren and Jairo Cano, "Cost Benefit Analysis of the Puebla Project," in Strategies for Increasing Agricultural Production on Small Holdings. CIMMYT, Mexico, 1970.

they had about 12,500 hectares under cultivation. Farmer interest in the project is classified by Jimenez to have shifted by years from hostility to skepticism to interest and finally to enthusiasm, and the institutions serving the project region from attitudes of skepticism to interest. The cost-benefit analysis of the project (Myren and Cano) indicated a ratio of 0.93 for the first two years of operation -- 1968 and 1969. As would be expected the heavy overhead costs on a relatively small production base gave a relatively low pay-off in the early years; the authors anticipate greatly increased benefit ratios in the years ahead, although their assumptions seem overly optimistic to the benefit of the project. Irrespective of the costs involved, the project is beginning to demonstrate that small proudcers in an area can be enticed to join into a production campaign which both increases the productivity of their resources and increases their incomes. Average maize yields of the Puebla participants moved about 3 tons per hectare in an area where yields normally average only slightly better than one ton. Farm incomes for participants in the program rose from about US$ 100/hectare for the traditional producers to US$ 240/hectare for farmers associated with the project.

But the question still remains, can the whole agrarian society progress with this model, or must a rapidly modernizing agriculture, perforce, operate on a highly selective basis and advantage a few while displacing the many? To the degree that the improved agricultural systems are widely accepted and diffused throughout the agrarian economy, the increased supply of products runs up against onerous demand restraints. Even in low-income countries the income elasticity of demand for agricultural commodities is low. Technical improvements

which have the potential to triple and even quadruple traditional production yields can spread rapidly; if they are pushed to incorporate the great majority of the established producers, the growth in output would overwhelm the capacity of the market to absorb them. Established internal markets are narrow. By way of illustration, consider a modestly large country which produces a million tons of wheat on a million hectares of land, and which imports an additional 500,000 tons, shifting as little as 200,000 hectares of land on the largest farms (in the Latin American context, conceivably less than 1,000 producers) to a high yielding variety system with average yields of 3.5 tons per hectare. Such a shift would raise domestic production enough to make up for the imports. Incorporating the additional producers, perhaps 50 to 100 thousand, would increase the quantity of product beyond any conceivable level of national consumption. A model of agricultural development which has worked with reasonable success in Western Europe and in the United States in an historical period following rapid industrial growth, with relatively low population growth and where much of the structural transformation from agrarian societies to industrial had already taken place, may not reasonably be expected to function smoothly or even acceptably in developing countries with primarily agrarian structures, high population growth, and only modestly functional industrial systems.

The two other views of the agrarian economy postulated above are both dependent on a highly stratified application of the modernizing technologies and, of course, this is the reality of recent agricultural development. The views diverge in terms of the expectations about

what happens to those who are left out. On the one hand, rural areas with sub-marginal resource bases could be left in subsistence agriculture, as could be those farmers in favored regions who because of institutional restraints may not be able to participate actively.[25] The assumed form of economic organization implicit in this view is one of constrained growth potential and of continuing relative scarcity. Intelligent policy and humanitarian concern will give substantial attention to welfare programs to those who are left behind, but the problems of constrained growth and limited productivity of a large fraction of the national society will make adequate welfare programs difficult to design and implement. There is also the very serious doubt that those who are condemned to wait on the side lines for their day in the sun will be willing participants.

The other alternative format is what might be called a forced urbanization-full employment-welfare state view. Here the agricultural revolution, which is underway in tropical agricultural regions, is the enabling mechanism. Basic food supplies can be produced by an increasingly small fraction of the national population. For the society as a whole there is only modest real social cost of shifting human resources from marginal farming enterprises to building the urban complexes so in tune with the desires of the masses of population not only for adequate food, shelter, and clothing, but even more for the excitement and satisfaction of urban life styles. Lauchlin Currie

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[25] William Thiesenhusen in "Latin America's Employment Problems," Science, 5 March 1971, argues for a program to implement a welfare oriented subsistence agricultural sector as an adjunct to a modernized commercial sector.

spelled out a version of this format almost ten years ago and without the hindsight which the Green Revolution has provided us.[26] Many of us for too long have looked with romantic urge and wishful thought on the development of a prosperous yeoman agriculture in regions so long dominated by semi-feudal institutions. Technological revolution in agriculture and communications has intervened and afforded us wider opportunities.

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[26] Lauchlin Currie, Accelerating Development. New York: McGraw-Hill, 1966.

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