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Technological Change and Income Distribution
In Latin American Agriculture*

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Social scientists and policy makers have long neglected the two inter-related problems which are emerging as the most perplexing that confront Latin America: unemployment and a highly inequitable income distribution.¹ Indeed, as new technology--like high yielding varieties, fertilizers, mechanical equipment--is adopted in the agricultural sector at an increasing rate, as is probable during the seventies, more joblessness and increased income flows to the already privileged are likely. Hence, at the end of the decade the distribution of income will undoubtedly be even more skewed than it is today--probably unacceptably so from the point of view of nearly everyone in the society--unless governments soon act to redress these increasing imbalances. Even if the spread of new technology were not so pervasive, the employment

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¹See the discussions of these issues in Solon Barraclough, "Employment Problems Affecting Latin American Agricultural Development," Monthly Bulletin of Agricultural Economics and Statistics (July-August 1969); Department of Social Affairs, General Secretariat of the Organization of American States, "The Unemployment Problem in Latin America," UP/Ser.H/VII.79, Washington, D.C., March 3, 1970; United Nations Economic Commission for Latin America, "Income Distribution in Latin America," Economic Survey of Latin America, 1969, Part III, E/CN.12/851, March 20, 1970, pp. 111-1 to 111-126a.

problem would probably become more serious as the decade passes: a work force born in the population explosion that began in the fifties will be reaching a labor market that may well continue to be slack.

This paper does not deprecate the necessity of technological progress any more than it seeks to portray technology as a deus ex machina. And it recognizes the intimate connection between the introduction of some forms of technology and that sine qua non for development: an agricultural surplus. Neither shall I question the desirability of economic growth itself, although we should be aware that criticism on ecological grounds is becoming sharper.² For example, one commentator claims: "The 'need' for more food justified overfertilization of the land, leading to eutrophication of the waters, and lessened fish production--which leads to more 'need' for food. . . . People are dying now of respiratory diseases in Tokyo, Birmingham, and Gary, because of the 'need' for more industry."³ Nor shall we be detained by a discussion of the necessity of population control which has been well documented by others.⁴

Omitting these issues from discussion allows me to concentrate on the reasons why the introduction of more new technology in agriculture is likely

²Economic growth is defined as an increase in GNP per capita while development is considered to be a more inclusive term encompassing economic growth along with "expanded opportunities and the human capacities needed to exploit them, [and] a general reduction of mass poverty, unemployment, and inequality." See Peter Dorner, "Needed Redirections in Economic Analysis for Agricultural Development Policy," American Journal of Agricultural Economics 53, 1 (February 1971), pp. 8-16.

³Garrett Hardin, "Nobody Ever Dies of Overpopulation," Science 171, 3971 (February 1971), p. 527.

⁴Suffice it to say that I believe that most development efforts will be difficult in countries where population growth remains above 2 percent a year. Conversely, however, cutting the birth rate will not per se result in development.

to result in a higher unemployment rate and an increasingly skewed income distribution and how government policies can modify these undesirable effects.

I must, in good conscience, also emphasize urgency, for the time to become concerned with this issue is now--before the Green Revolution⁵ grips the region more firmly. Indeed, the tendency of the Green Revolution to worsen distribution of income in those parts of Latin America characterized by a hacienda system will likely be greater than that reported for India and Pakistan in areas where high yielding varieties have been introduced.⁶

The development of new agricultural inputs has already had a profound effect on some crops in parts of Latin America. The case of wheat in Mexico is especially dramatic: the Green Revolution was born there with the research program of the International Maize and Wheat Improvement Center (CIMMYT). Research of the Center has been responsible for the average yield per hectare of wheat rising from 800 kg. in 1950 to about 2800 in 1970.⁷

But Green Revolution varieties currently require careful water control, and since there is much dry land farming in Latin America, wheat yields in all regions of Latin America have not followed Mexico's trend line. Furthermore,

⁵The definition of what constitutes a "green revolution" varies in nuance in the literature. I shall use it as a convenient shortcut phrase to mean: the application of new inputs developed by science and technology to traditional agriculture resulting in a dramatic crop increase.

⁶For Asian examples, see Walter P. Falcon, "The Green Revolution: Generations of Problems," Seminar paper given at the annual meeting of the American Agricultural Economics Association, Columbia, Missouri, August 10 and 11, 1970, to which this paper owes a heavy intellectual debt. With a higher level of average per capita availability, productive agricultural resources are more inequitably distributed in Latin America than in India.

⁷E.J. Wellhausen, "The Urgency of Accelerating Production on Small Farms," in Delbert T. Myren, ed., Strategies for Increasing Agricultural Production on Small Holdings. (Mexico: International Maize and Wheat Improvement Center, 1970), p.5

only a few basic crops in the region have been affected by these spectacular productivity gains. And when all of agriculture is considered, the production picture over the sixties was not bright in Latin America. The livestock subsector proved particularly weak. If the regional per capita agricultural production from 1961 to 1965 were represented by 100, the 1967 index number would be 100; that for 1968, 98; and the 1969 average, 97.⁸ In other words, any gains in output made by agriculture in this period appear to have been wiped out by Latin America's high rate of population growth. While some regions and commodities exhibited good production progress in the sixties, others stagnated.

But what has happened to wheat in Mexico portends a brighter production history for this decade; it is likely that many countries of Latin America will feel more of the effects of the Green Revolution in the seventies than in the sixties.⁹ Some countries have adopted agricultural research programs in the fifties and in the last decade which should begin to pay some dividends in terms of increased production in the next ten years. Experimentation by foreign investors seems to have played an important role in increasing corn yields in some parts of Chile, for example. Cultural practices in some areas have improved markedly, often through cooperation between U.S. and Latin

⁸"Regional" refers to twenty-two Latin American countries. U.S. Department of Agriculture, Economic Research Service, Indices of Agricultural Production for the Western Hemisphere Excluding the United States and Cuba, ERS-Foreign 264, (Washington, D.C, Revised April 1971), Table 2, p. 4.

⁹Especially good sources of information on the accomplishments of the Green Revolution are Falcon, "The Green Revolution: Generations of Problems"; Clifton R. Wharton, Jr., "The Green Revolution: Cornucopia or Pandora's Box?" Foreign Affairs 47 (April 1969), pp. 464-476; Lester P. Brown, Seeds of Change, published for the Overseas Development Council by Praeger, 1970; "Impact of the Green Revolution," Development Digest 7, 4 (October 1969), pp. 75-124.

American biological and social scientists.¹⁰ Foundation researchers and other scientists are hard at work on many crops other than those that have shown dramatic increases in the recent past and are even experimenting with a high yielding germ plasm for dry land wheat. Fertilizer use is increasing-- nearly eight fold in Latin America between 1948/52 and 1967 (compared to five fold in the rest of the world).¹¹ And, it is quite possible--even probable-- that more countries will undergo the "Pakistani experience." To explain this last point, in 1961 and 1962 young scientists from Pakistan who had received practical training in Mexico returned home with samples of high yielding Mexican dwarf wheats and with the basic knowledge of the cultural practices needed to make these varieties highly productive. Nobel laureate Norman Borlaug concludes, "Perhaps 75 to 80 percent of the research done in Mexico on cultural practices was valid in Pakistan. Research undertaken in Pakistan while the imported seed was being multiplied provided the necessary information to cover those gaps where the Mexican data were not valid. Many years were saved by drawing on the Mexican experience."¹² The outcome is legend. The 1970

¹⁰Being from Wisconsin I cannot help but mention the cooperation between Wisconsin and Brazilian scientists that has brought about some greatly increased yields in Southern Brazil. See, for example, "The Triumph of Goodwill and Cooperation," Alliança Reporter 5, 11/12, (Rio de Janeiro, November/December 1970), pp. 13-15. To cite another example, the research of Chilean researchers in cooperation with University of Minnesota scientists has had an important influence on corn yields in the Central Valley.

¹¹Solon Barraclough and Jacobo Schatan, "Technological Policy and Agricultural Development," (Instituto de Capacitación e Investigación en Reforma Agraria, Santiago, Chile, 1970), mimeographed, p. 8 and Table 1, p. 50.

¹²Norman E. Borlaug, "Wheat Breeding and Its Impact on World Food Supply," Proceedings of the Third International Wheat Genetics Symposium, Australian Academy of Sciences, Canberra, 1968, p. 13.

harvest in Pakistan was a phenomenal 8.4 million metric tons compared with 4.6 million tons harvested in 1965. Wheat production in Asia during 1969 exceeded the 1960-64 average by 18 percent. India expects self sufficiency in food grains in three or four more years.

The International Rice Research Institute provides a similar, if more limited, success story. Five years ago the Philippines imported one million tons of rice annually; today the country is not only self-sufficient but will soon begin exporting rice. And IRRI varieties are already being utilized by many other Asian nations.¹³

It is thus not unreasonable to expect that the seventies may well see most of the countries of Latin America enjoying substantial increases in agricultural production. Doomsday spokesmen who five years ago foresaw mass starvation by 1980 are now interspersed with those who view the world food problem as less of a specter.¹⁴ At least, the Green Revolution should make it more possible to buy the time necessary for countries to control their rapid rates of population growth; widespread famine no longer seems as imminent as previously. Borlaug claims, "As late as 1964 I was pessimistic about the ability of the hungry nations of the world to even temporarily solve their food production problems. Today I am optimistic about the outlook of food

¹³Wellhausen, "The Urgency of Accelerating Production," p. 6.

¹⁴Issues involved in this disagreement are outlined in the dialogue "Is Famine Inevitable?" War on Hunger, Agency for International Development, IV, 1, (January 1970), pp. 7-9.

production in the emerging countries for the next two or three decades."¹⁵ Wellhausen agrees and points out that ". . . Brazil has launched a new science-based program with hopes of supplying its own requirements of wheat by tripling production from one million to three million tons. Since Mexican varieties are not directly adaptable, Brazil has undertaken an extensive breeding program of its own as an essential first step."¹⁶ Wheat yields in Brazil remained practically unchanged from 1948/52 to 1967,¹⁷ but appear to have risen substantially since that time due at least as much to improved cultural practices as to new varieties.¹⁸ While some countries will experience no gains without arduous experimentation, others may fortuitously enjoy the shortcut of a "Pakistani experience." Bolivia and Ecuador, for example, hope to greatly increase wheat production with varieties developed in Mexico and Colombia.¹⁹

But providing self sufficiency in food production says nothing about what Falcon has called the "third generation" problems: How does the Green Revolution affect income distribution?²⁰ And how can public policy assist technology to bring about a more egalitarian distribution?

¹⁵Borlaug, "Wheat Breeding," p. 11.

¹⁶Wellhausen, "The Urgency of Accelerating Production," p. 6.

¹⁷Barraclough and Schatan, "Technological Policy and Agricultural Development," p. 9.

¹⁸See United States Department of Agriculture, Economic Research Service, Indices of Agricultural Production, Table 10, p. 12.

¹⁹Wellhausen, "The Urgency of Accelerating Production," p. 6.

²⁰Falcon, "The Green Revolution," especially pp. 13-15.

There is a widespread feeling among some academicians and students in the United States that technology is not amenable to manipulation—that as it is developed, peoples' life styles are changed and they are helpless to redirect its inexorable march or shape it to their needs. Jacques Ellul, the distinguished philosopher and theologian seems to be one of these, stating: "Enclosed within his artificial creation . . . man finds that there is no exit . . . he cannot pierce the shell of technology. . . ."21 Earlier this year Edward E. David, Jr., President Nixon's science advisor, told a seminar sponsored by the National Academy of Sciences that, "There are many evidences that society does not believe that technology can be controlled in a rational way."²² In contrast, I share Stewart Chase's view in that "I cannot follow the mystique that technology has laws of its own over and above human intervention."²³ This does not negate the fact that the introduction of all technology has its unforeseen consequences. But some outcomes can be anticipated. Energy and imagination must be directed toward formulating policies that will shape technology so that it helps to solve the problems that mankind faces now and will confront in the future. In agricultural sectors of Latin American countries some probable future impacts of new technology can already be discerned. To neglect coping with them merely asks that current social problems be exacerbated.

²¹Quoted in Stuart Chase, "Two Cheers for Technology," Saturday Review, (February, 1971), p. 20.

²²Philip M. Baffey, "Losing Our Nerve to Experiment?" Science, 71, 3974, (March 1971), p. 875.

²³Stuart Chase, "Two Cheers for Technology," p. 20.

The Effect of Technological Change in Agriculture on Income Distribution

Why, if present institutions and policies are not changed, will the technological revolution in agriculture likely create a more inequitable pattern of income distribution? In attempting to formulate an answer to that question, it will be convenient to divide the technological improvements in agriculture into two major categories and attempt to determine how, given the latifundio-minifundio land tenure system that prevails in most Latin American countries, each type has affected--and is likely to affect--income distribution. At its most basic level, technological change can be classified as consisting of "Green Revolution" inputs (those that tend to increase yield per hectare, such as improved seeds, fertilizer and better cultural practices which accompany them) and labor saving inputs (those that allow one man to cultivate more area, such as tractors and implements).

A. Short Run Effects of Green Revolution Inputs on Income Distribution among Landholders. The immediate impact of "Green Revolution" inputs in Latin America seems to be that they affect the upper end of the spectrum of income receivers more than the lower end: they add to the incomes of the already rich. Even though seeds and fertilizers are divisible so they supposedly may be used just as economically on large as on small farms, for several important reasons they currently are not neutral to scale in most Latin American countries. In the first place, as Crosson and Feder point out for Chile in the fifties (it is undoubtedly less true of Chile in the seventies) credit institutions and those that are charged with diffusing technical information are usually designed

for the large acreage farmer.²⁴ He is therefore more likely than the minifundista to adopt yield increasing inputs because he has access to sources of production information and credit. Lending agencies demand collateral. At least for long term credit, without adequate land farmers may have difficulty in obtaining funds they need. While land per se is not such a priority need to obtain short term loans, one still needs a minimum resource base to be considered credit worthy. Furthermore only men of some means have the time and education to cope with the red tape and delay endemic to many lending agencies. What is more, since high yielding varieties

²⁴Pierre R. Crosson, Agricultural Development and Productivity: Lessons From the Chilean Experience (Baltimore: The Johns Hopkins Press, 1970); and Ernest Feder (cited by Crosson) "Controlled Credit and Agricultural Development in Chile," University of Nebraska, August, 1959, mimeographed. A similar situation was reported in Chile based on fieldwork in 1965. See Darío Menanteau Horton, The Challenge for Change in Rural Chile: A Study in Diffusion and Adoption of Agricultural Innovations, Miscellaneous Report 89, (Agricultural Experiment Station, St. Paul: University of Minnesota, 1970). Dorner and Felstehausen feel this also prevails in Colombia. Peter Dorner and Herman Felstehausen, "Agrarian Reform and Employment: The Colombian Case," International Labour Review, 102,3 (September, 1970), pp. 221-240. Soles details the lending policy of the Caja Agraria Industrial y Minero, the largest agricultural lending institution in Colombia, in Valledupar and Codazzi municipios. In 1968 the Caja gave 974 loans of less than 10,000 pesos, representing only about 8 percent of the funds it disbursed; in 1969 it gave only 603 small loans representing slightly over 3 percent of its loanable funds in the area. The bulk of the credit (73 percent in 1968 and 88.5 percent in 1969) was given out in loans that were larger than 50,000 pesos. Similar results were found in ten other coastal municipios in the years between 1964 and 1970. Roger Soles, "Rural Land Invasions in Colombia," (Ph.D. dissertation, University of Wisconsin, 1971), preliminary draft material. In Central America export crops tend, more than domestic crops, to be grown by large scale farmers. Quirós estimates that in the late sixties, "Financial institutions are . . . oriented to service the needs of the dominant export sector. This is reflected in credit policies that allocate 65 percent of total loans . . . to the major export commodities and 13 percent to livestock. Only 12 percent . . . are allocated to domestic market crops." Rodolfo Quirós, "Agricultural Development and Economic Integration in Central America," (Ph.D. dissertation, University of Wisconsin, 1971), p. 239.

usually require from three to four times the amount of fertilizer than is currently applied for a favorable response ratio, there is a need for credit in greater amounts than ever before. Under the present system, the necessary quantities of these inputs are farther than ever from the reach of the land owning campesino. Currently, credit institutions that have been designed with the small scale farmer in mind are often so undercapitalized that they either are not able to serve the many campesinos who need loans or give many of them so little that credit has a negligible impact on income.²⁵ Or, if credit is available, either yield raising inputs may not be at hand or supervisors may not know the proper cultural practices--or at least may not be skilled at effectively communicating them to campesinos.

If it is left to other agencies, like extension services, to communicate farming techniques, it may well be that they are designed to serve large acreage farmers also. For the Green Revolution to be successful rather sophisticated skills need to be developed by farmers. If seeds and fertilizers are neutral to scale but credit to purchase them and technical assistance are not, small farmers will be more likely than large farmers to be unsuccessful adopters, non-adopters, or at least, late adopters.

²⁵The response pattern of some varieties may be such that little or no increase in production is possible without some critical minimum of fertilizer application. If a campesino uses less than this amount he may find it impossible to repay his loan because his production has not improved markedly.

Added to these problems, adequate irrigation facilities may be available only to large holders because locally controlled water associations are able to effectively block water use to minifundistas.²⁶

On the other hand, in the short run, the Green Revolution may have one favorable impact on the low end of the spectrum of income receivers: it may increase employment. The indication is that varieties that double or triple yields will require more labor, at least at times of harvest and irrigation. Further, double cropping may become more prevalent, with whatever increase of labor use that implies.²⁷

B. Effects of Labor Saving Technology on Income Distribution in Agriculture. A major part of the technological advance of the fifties and sixties has taken the form of the introduction of labor saving capital, and this technology tends to have its greatest unfavorable influence on the lower end of the spectrum of income receivers. That is, it increases rural unemployment and underemployment and provides one impetus for the massive in-migration to cities of Latin America where chances of finding a job are increasingly bleak.²⁸ There is nothing to indicate that the current trend toward

²⁶Of a sample of farms in the Valle del Illapel in Chile, Stewart concludes, "In spite of the existence of a canal association . . . with its formally established system of homogeneous water rights . . . there are great variations in the quantities of water actually received per share. . . . Deviations . . . appear to be directly related to differences in sizes of farm units and to relative distances of units from heads [sic] of ditches. To a lesser extent, they seem to be related to positions of influence within the Canal Association. These positions are themselves related to farm size." Daniel L. Stewart, El Derecho de Aguas en Chile, (Santiago: Editorial Jurídica de Chile, 1970), pp. 290-291.

²⁷Bruce F. Johnston and John Cownie, "The Seed-Fertilizer Revolution and Labor Force Absorption," The American Economic Review 59,4, Part 1, (Sept., 1969):pp.569-582.

²⁸See Department of Social Affairs, General Secretariat of the Organization of American States, "Unemployment Problems Affecting Latin American Agricultural Development."

mechanization²⁹ of farming is slowing down. Barraclough and Schatan note that the number of tractors more than quadrupled in Latin America while in the rest of the world it rose 2.3 times in the period between 1948/52 and 1967.³⁰

The conclusion of the ILO report on employment in the agricultural sector of Colombia is probably generalizable to much of the remainder of Latin America: "The growth of commercial farming since the Second World War in Colombia has been intimately associated with the use of machinery, which has . . . reduced the need for human labour (relative to output) on the farms concerned."³¹ That this is happening runs counter to the sound rationale of Johnston and Cownie: "In economies in which little structural transformation has occurred and the absolute size of the farm labor force is increasing rapidly, investment in tractor mechanization is likely to be uneconomic from society's point of view even though it is profitable to the large farm operators. . . . The social costs of exacerbating problems of underemployment and unemployment do not enter into their assessment of costs and returns."³² While made with particular reference to Asia, this statement has application to many Latin American countries also.

²⁹It is not always correct to equate the terms "mechanization" and "labor saving capital." As I point out later, some mechanization may be yield increasing while, in the case of chemical weed killers, labor saving capital may not be "mechanical" in nature. Quirós reports on cases where chemical weeding of coffee plantations reduced the permanent labor force by fifty to sixty percent and resulted in an increase in the use of seasonal labor during the harvest season, thus increasing underemployment. "In some areas chemical herbicides caused the displacement of permanent labor and its subsequent movement out of the area created labor shortages during the harvest." Quirós, "Agricultural Development," p. 214.

³⁰Barraclough and Schatan, "Employment Problems," p. 9 and Table I, p. 50.

³¹United Nations, International Labour Office, Towards Full Employment, (Geneva, 1970), p. 164.

³²Johnston and Cownie, "The Seed-Fertilizer Revolution," p. 574.

That mechanization is increasing despite a growing or stable work force in farming has something to do with governmental policy and the land tenure system: 1) When management is separated from labor, as it is in the hacienda, and when labor is ample and poorly organized and there is little or no labor legislation, there is little to stop landlords from firing workers who have few employment alternatives. On the other hand, while a family farm owner-operator may sell out, he cannot fire himself or his family. Likewise in a labor managed enterprise, it may be difficult to displace fellow workers with a machine. 2) In some countries where modernization is equated with mechanization, machines can be obtained at a favorable exchange rate, with cheap credit and long term credit arrangement. In other words, the large farmer is, in effect, subsidized for contributing to the unemployment problem. 3) In some countries minimum wage and fringe benefit legislation are increasing labor costs and making labor more expensive at the same time that mechanical power is becoming artificially cheap. 4) It is usually simpler to deal with a machine than with large numbers of campesinos. A machine tends usually to be predictable may be more dependable, and does not strike. 5) Sometimes aid from developed countries comes with "strings" that make it mandatory for the recipient to buy equipment in the nation that gave the aid.³³ This, in turn, encourages

³³An interesting account of one such loan which resulted in a shipment of tractors to Chile may be found in Jerome Levinson and Juan de Onís, The Alliance that Lost Its Way, (Chicago: Quadrangle Books, 1970), pp. 125-128.

the use of the latest labor saving machinery because machines tend to be developed for the factor proportions of the country in which they will find their biggest market.³⁴ To sum up to this point, initially Green Revolution inputs tend to make the income distribution more skewed by making the rich richer, while labor saving technology increases inequity at the other end of the income spectrum--it usually causes unemployment and underemployment in the countryside and cityward flight before industry is able to adequately absorb the labor.

C. Longer Run Effects of the Introduction of New Technology in Agriculture. In the longer run more interdependence between the introduction of yield increasing and labor saving technology and an important adverse effect on the lower end of the spectrum of income receivers in Latin America is probable. That is, the employment and underemployment problem may be exacerbated.

1) Current experimentation is with triple dwarf wheat varieties which have such short straw that they are difficult to cut by hand and shock. These varieties may render combine harvesting more economical than is the case with varieties having a longer straw. 2) In some instances labor saving technology is also yield increasing in nature. Green Revolution varieties may need such careful seedbed preparation that man cannot do the job with the hand labor available

³⁴These arguments are elaborated in William C. Thiesenhusen, "Population Growth and Agricultural Employment," American Journal of Agricultural Economics, 51, 4 (November 1969), 735-752; and William C. Thiesenhusen, "Latin America's Employment Problem," Science, 171, 3974, (March 1971): 868-874.

to him alone. Furthermore, if double cropping becomes possible, there may be more need for speed in harvesting one crop and planting the next one which will encourage mechanization. In areas where triple cropping is possible the pressure to mechanize may be even greater. 3) Falcon has pointed out that if wheat comes to be more profitable than some labor intensive crop, such as cotton, it may have a negative effect on employment.³⁵ 4) The Green Revolution may also eventually switch a farm's cropping pattern from a diversified one which spreads labor needs through the year to one in which there are peak times of great labor need and more "troughs" in which workers are idle. This may diminish the need for permanent labor while increasing the need for migrant and seasonal labor. More underemployment would seem to be the inevitable result. More specifically, it may be difficult to shift labor in sufficient quantities to areas of harvest--especially when vast acreages are ready for threshing at the same time. The Green Revolution tends both to increase yields and add to acreage planted with the high yielding variety. Seasonal labor scarcity and worker immobility is one reason that leads Borlaug to the conclusion, "Vast numbers of new harvesting machines are now badly needed."³⁶ 5) As domestic markets fill, prices for the commodity

³⁵Falcon, "The Green Revolution," p. 13.

³⁶Borlaug, "Wheat Breeding," p. 22. An example of what happens when new crops are introduced into an area dominated by hacienda agriculture is detailed by Quirós; his observations seem to have applicability in the event of a Green Revolution--or any other opportunity for profit that surfaces in the agricultural sector. He notes the manner in which the introduction of cotton into a live-stock-cereal economy in Pacific Coastal Nicaragua "totally upset the stability of this system of agriculture. [Land] tenure institutions made it simple

affected will drop. Farmers who have not been able to adopt the new technology may find that their meager crop will eventually have to be sold at lower prices. Since they cannot make up in quantity what they lose in price, their incomes will be less than previously. They may even have to switch to crops that were only their second choice before the technology was introduced.

6) As the early adopters increase their profits, they may become more and more willing to invest in labor saving technology even if labor remains relatively cheap. Especially in an inflationary economy, buying mechanical equipment may be a good investment. In some cases, on the other hand, the mechanical power is used merely for the pretige it confers on its owner. In their effort to show mechanization as a necessary concomitant of modernization, Johnston and Cownie report that, "In West Pakistan . . . many agricultural leaders and development economists are declaring that the 'bullock is obsolete.'"³⁷

to divest campesinos of land to make room for large-scale production of cotton. . . Many independent campesinos, lacking financial resources or technical knowhow, had to rent their land or join the cotton expansion on a modest scale. The end result was a massive displacement of campesinos from their land. Displaced campesinos were forced to emigrate to other frontier areas, join the migrant labor force, or crowd into the minifundia sector. In Nicaragua, . . . labor displacement followed by emigration to other areas was of such magnitude that as early as 1964, an estimated five percent of the cotton crop was lost because of regional labor shortages. . . . The first thirteen mechanical pickers were imported in 1964 and by 1967 their number had grown to 200. In this case . . . there exists the seemingly paradoxical situation of (regional) labor shortages amidst widespread (national) unemployment and underemployment." Quirós, "Agricultural Development and Economic Integration," 181-183.

³⁷Johnston and Cownie, "The Seed-Fertilizer Revolution," p. 574.

7) If mechanization frees up grazing land that was used for draft animals for a highly profitable Green Revolution crop, it may represent a sound private economic decision. 8) As Green Revolution inputs begin to increase the profit margin in farming, land prices will rise. This will increase the net worth of agricultural real estate in Latin America,³⁸ (and, by the way, serve to reinvigorate the political and economic position of the landlord who has been steadily losing power and prestige to other elites). If renting is a common form of land tenure arrangement, the landholder will probably be able to prevent the appropriation of these windfall profits by a tenant; being the strongest party to the bargain (because there are so many potential renters) a landlord can always increase the rental payments he requests. It is possible that share-croppers and resident laborers (who are given a plot of their own to farm) would benefit, but Ladjinsky's observation about India is likely to hold true in Latin America. He warns, "The share-croppers are, if anything, worse off now than before because as ownership of improved land is prized very highly there is mounting determination among owners not to permit the tenants to share in the rights of the land they cultivate. Their preference is to be rid of them."³⁹ 9) While internal pressures to mechanize are most important,

³⁸This has happened in Punjab and the Purnea district of Bihar in India. See Wolf Ladjinsky, "Ironies of India's Green Revolution," Foreign Affairs, 48, 4 (July 1970), p. 764.

³⁹Wolf Ladjinsky, "Green Revolution in Behar-Kosi Area: A Field Trip," Economic and Political Weekly, 4, 39, (September, 1969), quoted in M.L. Dantwala "From Stagnation to Growth: Relative Roles of Technology, Economic Policy and Agrarian Institutions," Presidential address, Indian Economic Association, Fifty-third Annual Conference, Gauhati, December 1970, p. 20.

external pressures--centered in developed countries--may add to the pressure for mechanization. For example, a large North American tractor firm probably is not working on the program to improve wheat varieties and cultural practices in Brazil for reasons that are purely altruistic.

Policy Suggestions

If we agree that vastly increased joblessness and a more skewed income distribution in the seventies will be unacceptable to society, what policies should be followed to prevent this from happening?

Since Green Revolution inputs are divisible in theory if not in fact, an effort must be made in all Latin American countries to change land tenure patterns so that land is controlled by those who work on it. Concomitently, governmental service and marketing institutions must be reformed so that inputs and the knowledge of how to use them become available to the existing small-scale farmers and beneficiaries of agrarian reform programs. This means a land reform program coupled with institutions that service the existing small farm sector as well as the newly created reformed sector with credit, fertilizer, markets, and technical information.

There is evidence that small-scale farmers need not be denied the benefits of Green Revolution technology because of their size. In other words, lack of adoption is probably more due to society and the structure of its institutions than to farm size and farmer psychology. As seems also to be the case in southern Brazil, in India where a system of land tenure nearer the

family farm than the latifundio-minifundo complex prevails, it has been shown that new technology has not wholly by-passed the farmer with a miniscule plot. Chowdhury finds that net return per rupee spent does not improve with the increase in farm size.⁴⁰ Mukherjee also found that for wheat in Punjab, all size groups of farmers participated in the high yielding variety program. In Tamil Nadu, for paddy for the lowest-size group--below 2.5 acres--the proportion of those who used high yielding varieties was as high as 70.3 percent.⁴¹

A. What can agrarian reform contribute to development? I am not claiming that the result of land reform must be small scale farming. Labor managed schemes such as the Chilean asentamiento and the cooperative system being established on the Peruvian coast may be alternatives especially if they are organized along regional lines. But I am arguing that half-hearted reforms will not have the desired results. Reform must be, to use Chonchol's phrase, "massive, rapid, and drastic."⁴² The institutional structure of agriculture must be changed to make it possible for Green Revolution inputs to benefit the campesino; later, these inputs and the knowledge of how to use them must be provided. It is doubtful that the entire job can be done at once;

⁴⁰B.D. Chowdhury, "Disparity in Income in the Context of High Yielding Varieties," Economic and Political Weekly, 5, 39, (September, 1970), p. A-91, quoted in Dantwala, "From Stagnation to Growth," p. 19.

⁴¹Mukherjee, P.K., "The High Yielding Varieties Programme: Variables that Matter," Economic and Political Weekly, 5, 13, (March, 1970), p. A-15 quoted in Dantwala, "From Stagnation to Growth," p. 19.

⁴²Jacques Chonchol, El desarrollo de America Latina y la reforma agraria, (Santiago: Editorial del Pacifico, 1964), p. 88.

resources are scarce. But it is especially important for countries to reshape the institutional structure as a first step.

If an effective agrarian reform program were instituted, it could have the following favorable effects on the economy:

1. Slow the rate of farm-to-city migration by employing people more productively on the farm until industry is ready to employ them.

2. Increase the demand for simple consumer goods since the economy would rest on a broader base. In addition to providing more jobs in the countryside, land reform should yield more city jobs, too. Products which beneficiaries of agrarian reform are likely to demand are textiles, processed food and clothing; and methods of manufacture for these items are typically more labor intensive than for consumer durables.⁴³

3. Provide a more regional basis for industrialization; for example, agricultural processing could be done in regional capitals, thus creating more jobs outside of the central city.

4. Affect balance of payments favorably since simpler goods require fewer imported inputs than more complex goods, and it is more economically feasible to manufacture simple consumer goods than consumer durables while countries are poor.

⁴³Clark details purchases by Bolivian campesinos in the northern highlands before and after the reform and shows they made four times as many cash purchases, mainly of simple consumer goods, in 1966 as in 1952. Ronald J. Clark, "Land Reform and Peasant Market Participation in the Northern Highlands of Bolivia," Land Economics 64 (May 1968), Table 1, p. 161 and Table 2, p. 169.

5. Permit more revenues from agriculture to flow to the government which will no longer be dealing with the predominantly large-farm landlords who are so adept at evading taxation. If these public funds are invested wisely, economic development could proceed at a faster rate. As campesinos find that they are able to make purchases, they may well increase their production to enable them to buy more consumer goods. At that time, tax systems should be devised to capture an increasing share of increasing income.

6. Lessen the growing disparities of income distribution in the farm sector.

Furthermore, the time to act is now. Land will be increasingly difficult to distribute as the Green Revolution occurs and farming becomes more profitable. That is, landlord pressure to hold onto their property will increase. Dantwala remarks that in India the Green Revolution has "augmented the temptation for the big farmer to get more securely entrenched and for the wealthy and the influential to enter the field."⁴⁴

Land reform, then, provides the institutional context within which the Green Revolution can benefit a broader spectrum of the populace. It also tends to create more jobs--or, at the very least, should serve to deter displacement of men with machines from continuing at its present rate.

⁴⁴Dantwala, "From Stagnation to Growth," p. 20. I do recognize that there is another possible side to this issue: as campesinos sense that farming is becoming more profitable, they may step up their pressure for reform.

B. After Land Is Redistributed, How Can New Technology Be Made

Available To Campesinos? As we have stressed, preparing the institutional milieu is only the first step. The next one involves making the new yield increasing inputs available to the farmer as fast as research provides them and providing the campesino with the knowledge of how to use them. On this point there is less information, and most solutions to date carry a high price tag per farmer benefitted; hence, programs have reached very few farmers.

There are some useful models, however, that may be briefly described. But the main point to be made is that whatever the scheme, a technological package of inputs must be available that, if correctly used, will markedly raise production. At the same time, some kind of supervised credit program is needed to encourage the adoption of this technology by small farmers. The history of agricultural development in Latin America is littered with accounts of supervised credit plans that failed--frequently because the proper yield raising technology was simply not available or was not known by credit supervisors.

CIARA in Venezuela

A rather high cost model which could be modified in poorer countries is the CIARA program (Fundación para la Capacitación e Investigación Aplicada a la Reforma Agraria) that operates in Venezuela with funds from the national agricultural bank. Basically, it makes loans to agrarian-reform-created asentamientos which, in Venezuela tend to be settlements of individual owner-operators. Credit tends to be meted out only when there are good chances of

its economic success--when the technology for increasing yields is known.

In general, only asentamientos with a rather strong local organization are chosen for participation. Under this scheme a "Borrowers Union" is founded--with all those who wish to receive loans as members--to provide an institutional context for the loan receipt and to bring pressure to bear on would-be defaulters. In regular meetings the union discusses its production and credit problems and arranges for a certain amount of mutual assistance. Each Union is given some technical advice by an agricultural technician (perito agrícola) who services it and several neighboring unions. There are certain economies of the program which trace directly to the union. The banking process is streamlined by having one borrower per union rather than having each individual deal with the bank. Input orders can be pooled and handling and delivery costs reduced.

Besides strict supervision and the provision that nearly all who want credit can receive it, there are other differences between CIARA and the regular small holder credit program of the bank. The latter issues cash at three times during the growing season; the CIARA program provides credit as needed throughout the growing season. It is issued mostly in kind to help insure that the proper blend of inputs are used. The regular program did not fill the total normal input needs for a crop; CIARA plans the amounts of the loans so that they completely cover operating costs from soil preparation to harvest. And when machine work is needed, the operator is paid directly by the borrowers union after the work is accomplished and a signed receipt presented. Cash is

loaned directly only when campesinos have to pay labor or when funds are specifically approved for consumption purposes.

To decide on the physical inputs required, a detailed asentamiento cropping plan is prepared. Officers of the sindicato (primarily the secretary general who is an elected asentado) and the perito agrícola discuss possible alternative cropping plans for each farm with its owner well in advance of the planting season. In accordance with CIARA's "one step at a time" policy, however, the cropping alternatives open to farmers the first year they participate in the program are quite circumscribed; parceleros who want to grow non-traditional crops are invariably turned down. CIARA's first priority is to close the wide gap between current and potential productivity in the traditional crops in which all campesinos have prior experience. It was estimated that, on one settlement studied, given proper management and a satisfactory input mix, corn yields could economically be pushed to an average of 2,500 - 3,000 kgs. per hectare, from the 1965 and 1966 levels of 749 and 1,282 kgs. respectively.⁴⁵

After each farm plan is complete, the perito agrícola combines those of all farms on the asentamiento. The master plans goes to the ingeniero agrónomo

⁴⁵William C. Thiesenhusen with Ricardo Alezones, Ramón Pugh and John Mathiason, Leonardo Ruiz Pineda: A Case Study of a Venezuelan Agrarian Reform Settlement, Research Paper No. 7, Inter-American Committee for Agricultural Development issued by the Pan American Union (December 1968), pp. 35-37.

for the zone who combines all of the asentamiento plans in the state. Then the technicians decide what inputs would have to be supplied, how much tractor work would be needed, how much day labor is to be financed, and (allowing for some flexibility) the amount of cash subsistence payment needed. When changes in the farm plans designed at the asentamiento level have to be made, they are discussed with the perito who takes up the matter with the farmers. The complete plan with the necessary inputs is finally approved at a general meeting.

The bank issues to the borrowers union the total amount of credit called for; the ingeniero agrónomo orders all inputs in truck loads. For cash needs, a local bank account in the name of the borrowers union is opened. The union draws checks on it which must be signed by one of its elected officials.

There is very little data on the success of this program, but in at least some asentamientos production seems to have substantially increased. In 1965, 88 percent of production loans were repaid at the end of the year; the figure reported for 1967 was 88.3 percent. This represents a substantial increase over pre-CIARA days when agrarian reform beneficiaries came to regard production loans as a subsidy. Repayment rates in themselves are some indication that production is rising. Under the old system, with no package of prescribed inputs available, campesinos frequently used an incorrect combination and did not get a favorable response. Hence it was impossible for them to repay. The number of beneficiaries rose from 77 in 1964 to 7,959 in 1969. It

was estimated that 13,172 would receive credit in 1970. The amount loaned rose from Bs. 181,000 in 1964 to Bs. 37,697,832 in 1969; in 1970 a budget of Bs. 80,482,400 was planned.⁴⁶

The Puebla Project in Mexico

The Puebla project in Mexico is designed as a regional project to rapidly increase corn yields on 50,000 small holdings and operates on a different model. The area includes a large number of small scale farmers who were consistently receiving low corn yields (just over one ton per hectare) despite a favorable ecology. At the beginning of the project (1967) the average holding in the area was 2.5 hectares, primitive equipment was used, little capital was invested in agriculture, adults had an average of 2.5 years of schooling, average family size was five to six members and family income was about US \$505. During 1967 an intensive effort was made to conduct experiments on thirty farms using different combinations of fertilizer, improved hybrid seed, and tillage practices. During the year the first 103 farmers were also selected to apply the results of this experimentation to 76 hectares of their own land planted in 1968. This group obtained credit, proper inputs, crop insurance, and a steady flow of technical information throughout the year. On the average, farmers on these demonstration plots doubled their 1967 production in 1968. During the growing season field demonstrations were conducted in

⁴⁶Rafael Cartay Angulo, Algunas consideraciones sobre uniones de prestatarios y crédito dirigido, (Caracas: Instituto Agrario Nacional, 1970), pp. 16-17.

order to pique the curiosity of other farmers in the area and capture the interest of service institutions. In 1969, support of the secretariat of agriculture and the government of the State of Puebla was assured. As the number of farmers who wanted to participate in the program grew, it became impossible to have available technicians work with each individual farmer so the campesinos were encouraged to organize. The number of participants increased to 2,561 farmers in 1969 and 4,833 in 1970. Thirteen technical people now work on the project, and methods of information dissemination are becoming so efficient that even when the program reaches 40 to 50,00 it is estimated that there will need to be little expansion of staff.

It appears that the 1970 harvest will be substantially higher than that of 1968. The land area devoted to high yield plantings grew from 76 hectares in 1968 to 12,496 in 1970. The farmer using his traditional agricultural system obtained, on the average, a net income of less than US \$27.35 per hectare. Farmers who are participants in the project were able to increase this figure to nearly US \$126. The success of the project has also made its participants more credit-worthy. In 1968 the equivalent of US \$226,616 was loaned. Over three times that amount was loaned in 1970 and it came from public and private sources. Of that credit granted in 1969 over 96 percent was repaid. The success of this project to date seems to rest on the fact that needed technology was available, and that farmers were able to see for themselves that improved cultural practices could pay off. They are now anxious to participate in the

program. Also time was taken at the beginning of the program for on-site experimentation with cultural practices so that initial technical mistakes could be avoided.⁴⁷

B. Implications for Post-reform Strategies for Obtaining Production Increases from Land Owning Campesinos. We could cite a number of other programs--such as, for example, INDAP and CORA in Chile, and they all seem to lead us to the conclusion that it is possible to obtain substantial production increases from campesinos after an agrarian reform if a proper technological package and adequate credit are available. The foregoing leads me to policy suggestions that I believe must be considered if governments are to avoid facing the unpleasant consequences of a worsened distribution of income and an unacceptable level of unemployment and underemployment in the seventies as more new technology is introduced:

1) If it is true that Green Revolution inputs can be used as effectively--or even almost as effectively--on small farms as on large ones, there is no good economic reason for not pressing ahead with thorough-going agrarian reform programs since they would permit more on-the-farm employment, and a more even distribution of property would lessen the growing disparities in income. They would provide stimulation to other industrial sectors and, if correctly designed, will permit a more effective system of taxation. There is a good political

⁴⁷Summarized from Leobardo Jiménez Sánchez, "The Puebla Project: A Regional Program for Rapidly Increasing Corn Yields Among 50,000 Small Holders," in Delbert T. Myren, ed., Strategies for Increasing Production, pp. 11-18.

reason for agrarian reform now since the Green Revolution is likely to increase the political power of the landed.

2) Since we realize that technological change necessitates institutional change, we also need to be aware that changes in institutions will require changes in technology. More research in Latin America should be concentrated on shaping technology to campesino farming. If factories for the manufacture of small scale machines, like garden tractors, were established in the region, would it be possible to create more employment and utilize less foreign exchange to import machines than currently? Furthermore, the Green Revolution must press ahead, and research work on yield increasing inputs must go forward. But social science research should help us to understand the impact of changing technology on the masses of those working in the agricultural sector, and how that technology may be shaped to their needs should be an accompanying priority.

3) Likewise, extension and credit institutions should be established for small scale farmers, and we must learn more about how to effectively communicate applicable research results to campesinos. CIARA--and even Puebla-- provide a model that is too expensive for most countries, but programs along these lines could be designed more economically by:

- a. providing a package of inputs together with technical information, ample credit, and a market for the crop in a manner similar to CIARA. In Chile, this has been done along commodity lines by several organizations, notable among them the National Sugarbeet

company. This program may have had multiplier effects: if, for example, a campesino sees that it pays to fertilize his sugar-beets, he may also attempt to obtain fertilizer for his corn and wheat. A package-of-inputs approach may mean that a farmer need be contacted only one time a year, and private enterprise might even be interested in such a scheme.⁴⁸

- b. working with farmers who are already organized. If a well functioning cooperative or union is established, the technical person may be able to work through several key leaders who then become responsible for disseminating results further or for planting demonstration plots.
- c. establishing demonstration plots. Farmers in Puebla became increasingly more anxious to participate in the program when they saw their neighbors succeeding in raising their production.

4) Just as the social scientist must use data from the biological scientist, the geneticist must become more aware of social problems. Is it absolutely necessary to breed a wheat so short it is most economically harvested

⁴⁸Brown's research in pre-Frei Chile led him to be quite critical of the traditional type of extension services patterned on the U.S. model. He concludes, "Extension programs which enjoy the most rapport with farmers, and which are generally regarded as the most effective in Chile, are those that . . . provide a package of services to farmers. . . . They give credit, distribute inputs, and provide a firm marketing contract with the price fixed before planting time. . . . This approach may be especially useful for agrarian reform. Contracting the production of certain key crops with new landowners would seem to have several advantages: (1) Colonists would have much-needed market security during the crucial first years. A more conventional extension program, even if it succeeded in

with a combine? What are the trade-offs between shorter straw and more production and longer straw and more employment? Scientists, social scientists, and policy makers must become more aware of the social implications of new technology. As one commentator has observed, "The emergence of the scientist as an active, responsible, if biased, citizen was a relatively radical idea a few years ago; this role is now more widely accepted. But the important thing is not the politicization of science, but the active involvement of scientists and engineers in those areas where decisions in uses of technology are really made."⁴⁹ This argues for clear channels of communications between the social and biological scientist and the scientific community and government policy makers.

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I have not attempted to argue in this paper that it is impossible to obtain the substantial short run production gains from agriculture should the present latifundio-minifundio remain intact. As the Green Revolution becomes a reality throughout Latin America, commercialization of haciendas--many of

raising production, would not provide a secure market. (2) By concentrating on single crops within given areas, agents could give better advice and improve rapport with their clientele." Marion R. Brown, "Agricultural 'Extension' in Chile: A Study of Institutional Transplantation," The Journal of Developing Areas, 4 (January 1970), p. 207.

⁴⁹Lewis M. Branscomb, "Taming Technology," Science 171, 3975 (March 1971), p. 977.

which were idle or poorly utilized previously--will probably become highly profitable, and marketable surplus should rise. Thus the Green Revolution will allow Latin America to buy a decade or more of time to control her population problem via more humane methods than widespread famine. But if this happens--if institutions do not change--the income benefits of agricultural production, which currently flow to a very few will continue to enrich those who already hold the bulk of the nation's agricultural resources, while campesinos who comprise the vast majority of those in agriculture will fall further and further behind. There is no reason why the same production gains could not be made by beneficiaries of an agrarian reform, thus ameliorating adverse effects of a worsening income distribution and more unemployment and underemployment. But in many Latin American countries this necessitates a massive agrarian reform program. It also means that the Green Revolution inputs must be channelled to new land holders as soon as research makes them available. And it requires that each step toward further mechanization be carefully scrutinized in terms of how much employment is lost for every increment gained in production.